



**PHD**

**Rational expectations test and excess sensitivity test of consumption**

Yu, Ge

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**RATIONAL EXPECTATIONS TEST  
AND EXCESS SENSITIVITY TEST  
OF CONSUMPTION**

by

Ge YU

A thesis submitted for the degree of  
Doctor of Philosophy

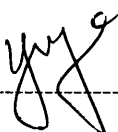
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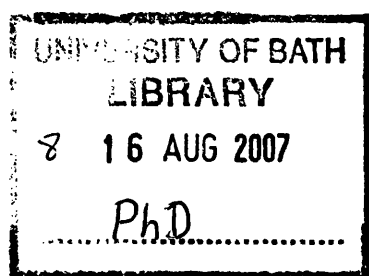
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UNIVERSITY OF BATH

## **Abstract**

RATIONAL EXPECTATIONS TEST  
AND EXCESS SENSITIVITY TEST OF  
CONSUMPTION

by

Ge YU

Benchmark models of optimization, in the spirit of the Rational Expectation Permanent Income Hypothesis, present a strong theoretical case for a smooth consumption regime in which households do not let consumption fluctuate with anticipated variations in explanatory variables. However, numerous studies in the past have empirically rejected the primary underpinning of the theory in aggregate level. This study attempts to provide substantial insight into the nature of household consumption dynamics over a life cycle with relation to subjective data derived from the British Household Panel Survey and examines the cause for the failure of the baseline theory. These subjective data are used to test the rationality of consumer expectations and to assess their usefulness in forecasting expenditure. The results can also be interpreted as characterizing the shocks that have hit different types of households over time. Individuals' expectations are found to be biased, at least ex post, in that forecast errors did not average out over a sample period lasting 12 years. Forecasts are also inefficient, in that people's forecast errors are correlated with their demographic characteristics and/or aggregate shocks did not hit all people uniformly. Further, financial situation variables are found to be useful in forecasting future consumption, even controlling for demographic variables. This excess sensitivity is counter to the rational expectation permanent income hypothesis.

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## *Chapter 1*

# **BACKGROUND AND INTRODUCTION**

## **1.1 INTRODUCTION**

The relationship between aggregate consumer's expenditure and their aggregate disposable wealth is one of the most thoroughly researched topics in quantitative economics. From around the 1940's, after Keynes (1936) emphasized the role of the consumption function in his general theory<sup>1</sup>, economists started to pay more attention to the consumption function. The traditional view of consumption over the business cycle suggests that consumption decreases in output but is expected to recover after that. In other words, there exist predictable movements in consumption. Modern economists examine consumption in terms of an optimizing problem whereby economic agents allocate their lifetime wealth to maximize their lifetime welfare, both at the micro and at the aggregate level. The Permanent Income Hypothesis (M. Friedman 1957) and the Life Cycle Hypothesis (Franco Modigliani, R.E.Brumberg 1954) have played an important role in the evolution of the consumption theory, which is referred jointly to as PIH/LCH in this thesis hereafter. The PIH/LCH suggests consumers set their current and future consumption to an appropriate fraction of their income on the basis of a forecast of their expected future stream of income. The fraction of estimated income to be consumed in each period would take the form of the annuity value of wealth (Franco Modigliani, R.E.Brumberg 1954) or of permanent income (M. Friedman 1957). In sum, the theory proposes that consumption should follow a smooth pattern over a life cycle, depending only on the permanent component of the individual's income, and should not fluctuate along with any transitory components. The PIH/LCH has dominated as the benchmark model of consumption-saving behaviour for over half a century. The only significant change over this period is the

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<sup>1</sup> Keynes (1936) claimed that "it is also obvious that a higher absolute level of income ... will lead, as a rule, to a greater proportion of income being saved".



assumption of rational expectations as the mechanism driving agents' forecasts. In turn, this has led to a more rigorous treatment of uncertainty.

In general, in the last couple of decades economists have used large macroeconomic models to forecast economic behaviour associated with the assumptions of the rational expectations framework. The rational expectation extension of the PIH/LCH, first presented by Hall (1978), suggests that change in consumption behaviour ought to be unpredictable under certain conditions. This is because changes in consumption will reflect the new information that becomes available to a consumer. By introducing a quadratic utility function, Hall shows that consumption changes are inherently unpredictable because this new information is both unknowable by nature and immediately processed by the consumer. In other words, Hall's random-walk hypothesis clearly states that if agents are forward looking and have rational expectations, current consumption should only be related to the most recent period's consumption while all other lagged variables should be irrelevant in predicting present consumption. However, while substantial theoretical and empirical researches, based on the PIH/LCH and the rational expectations extension of it (REPIH), have been conducted, this has not been able to establish sufficient common ground with respect to explaining the consumption profiles over the life cycle. The majority of the theoretical, as well as the empirical literature, indicates non-smooth patterns of consumption over the life cycle, counter to what has been proposed by the PIH/LCH/REPIH.

## 1.2 PROBLEM STATEMENT

It is perhaps unfair to reject the REPIH based on the evidence from aggregate data. Hall's framework is appealing because economists continue to seek an explanation for consumption behaviour as the result of an intertemporal maximization problem where agents are assumed to be rational. It can be argued that the reported failure of the REPIH is mainly due to the strong assumptions that have to be made in order to obtain an expression for consumption in levels from the (first order condition) Euler equation in which expected marginal utilities are required to remain the same over time. As a result, many economists are trying to understand what happens to consumption behaviour when we move away from the assumptions made by Hall and Flavin (1981). For instance, Zeldes (1989), Caballero (1990), Kimball (1990), Deaton (1991) and Carroll (1991;1992) find that it is very difficult to solve the first order condition to obtain an expression for consumption. But this does not mean that we cannot test the Euler equation. Attanasio (1998) discusses this point at length and concludes:

*'Even if it is not possible to obtain a closed form solution for consumption, it is possible to consider equilibrium relationships that can be used to estimate structural parameters. While these [...] are not sufficient to answer many important policy questions, they constitute a basic ingredient of any answer.'* (pp. 20-22)

But Hansen and Singleton (1982;1983) state that the principal weaknesses associated with if estimating equilibrium relationships are that instrumental variables are often required. Also the tests involved are not very powerful, while those that are used to determine the truth of the behavioral relationship tend to be then orthogonality tests.

Economists have tried to explain why consumption does not follow a random-walk in aggregate data in theoretical and applied econometrics. There is much empirical evidence that consumption reacts too strongly to current income and too little to permanent income. Those two findings are commonly referred to in the literature as the excess sensitivity and excess

smoothness puzzles of consumption respectively. Attanasio (1998) presents the explanation for the failure of the REPIH. He argues that aggregation issues make it very difficult to be able to predict or explain consumption behaviour accurately based on a representative agent framework. If it were, then we would be left with nothing to say about most of macroeconomics, let alone consumption.

### 1.3 OBJECTIVES OF THE STUDY

The general objective of this thesis is to provide a comprehensive analysis of the consumption behaviour based on household-level cross-sectional time series data using the REPIH as its theoretical foundation. This is to establish whether agents attempt to smooth their consumption through their lifetimes at the micro level. Thus this research has two main objectives: to quantify the failure of the random-walk hypothesis using direct household-level data on expectations; and to explain what factors or behaviours account for this.

It is vital that economists discover what drives individuals to be optimistic or pessimistic and hence, what motives behaviour such as spending, saving and investment. As a result, another objective of this thesis is to exploit more subjective data to explore its usefulness in forecasting households' consumption behaviour. This is because subjective data on respondents' intentions plays an important role in many fields like psychology, sociology, and political science, while in economics, its role has changed from being viewed as the negative in history<sup>2</sup> to a more positive assessment in the recent literature<sup>3</sup>. For example, life-cycle models exploring intertemporal consumption behaviour are driven by expectations of future income. Deaton (1992) states that consumers' behaviour not only depends on current variables, but also on the subjective distribution of future variables. Whilst economic theory is based on utility maximising behaviour, revealed preferences are often used to test the validity of competing theories in empirical economics. Hence subjective data can provide a direct proxy for utility in empirical work.

In the majority of empirical life cycle models, there are three common assumptions derived from the theoretical literature on how agents form their expectations: rational expectations; adaptive expectations; and naive

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<sup>2</sup> Tobin (1959); Keane and Runkle (1990). They found data collected in the Michigan surveys to be of little or no predictive value in microeconomic analyses.

<sup>3</sup> Dominitz and Manski (1996;1997); Das and van Soest (1996;1997); Guiso, Jappelli, and Terlizzese (1992;1996); Ilmakunnas and Pudney (1990)

expectations. However, while the rational expectation revolution of the 1970s is the basis for most of today's macro models, there has not been much empirical work done to test if this theory provides a realistic description of actual behaviour using actual empirical data on expectations. By using micro data, this thesis also exploits its panel aspect to test more cleanly than usual whether expectations are unbiased and efficient.

In sum, this thesis sets out to examine two inter-related propositions, the rationality of consumer expectations and their usefulness in forecasting expenditure. The specific objectives of this thesis include:

- To test the rational expectations hypothesis with micro data sets from the UK over a relatively long time period (12 years).
- To explore the determinants of individuals' financial expectations.
- To investigate if expectation errors contain systematic components and particular groups prone to be financially over-optimistic or over-pessimistic.
- To carry out excess sensitivity tests on a benchmark model to evaluate the validity of the random-walk hypothesis by exploring whether individuals' expectations can help to predict their consumption behaviour.
- To test for the existence of myopic, liquidity constraint, and asymmetric preference behaviour in household consumption decisions as an attempt to find possible explanations for the excess sensitivity puzzle.
- To explore whether systematic heterogeneity is another possible source of excess sensitivity of consumption.

## 1.4 OUTLINE OF THE STUDY

This thesis is organized into eight chapters. Chapter 1 provides an introduction and background to the thesis. Thus it outlines the main features of the problem under consumption, and describes the objectives of this thesis. Chapter 2 provides a review of the most important developments in the theoretical consumption literature. As a result it describes the literature on the random-walk hypothesis (REPIH), introduces some key empirical evaluations of it, and presents the main theoretical and empirical explanations of the likely causes of its failure. Thus the literature review seeks to establish an understanding of the development in the consumption theory and in estimation techniques. The first and second parts of the literature review deal with the empirical and practical issue concerning rational expectations and excess sensitivity tests respectively, and are carried out by a review of some of the relevant empirical work. Chapter 3 describes the data employed in this thesis while Chapter 4 introduces the panel data models used in this applied work. Chapters 5-8 form the substantive empirical chapters of this thesis. Chapter 5 tests the rationality of expectations, explores the determinants of individuals' financial expectations, and more generally characterizes the properties of forecast errors. Chapter 6 tests whether households' expectations help to forecast their expenditure, and if so, whether this is due to myopic, liquidity constraints, or asymmetric preference. Chapter 7 provides further analysis by investigating whether systematic demographic components in expectation errors can explain the failure of the Rational Expectations Permanent Income Hypothesis. The results of empirical analysis are drawn together, with conclusions, in Chapter 8.

## *Chapter 2*

# **LITERATURE REVIEW**

### **2.1 INTRODUCTION**

The basic aim of this chapter is to provide a background to the theoretical and empirical literature pertaining to consumption theories. The background is presented in two parts. The first part describes the Rational Expectations Hypothesis (REH) in terms of the developments in the modern consumption theories; with in the second part presents the Rational Expectations Permanent Income Hypothesis (REPIH). Both of hypotheses are discussed based on theoretical and empirical aspects. As a result, this review concentrates upon the approaches derived from REH, and REPIH within the context of a non-durable consumption decision-making process.

## 2.2 REVIEW OF CONSUMPTION LITERATURES

By the early 1970s the utility maximizing assumption had dominated the profession's thinking about consumption behaviour for a long time. This has been due to their theoretical desirability and their econometric performance.

However, in the 1970s, three important factors combined to draw a renewed interest in the consumption literature and to make it one of the most abundant areas of recent economic research. Firstly, the theories started to encounter difficulties in empirically predicting the behaviour of consumption accurately when the underlying economic environment became more volatile in the 1970s. Empirical economists found that the previous stable relationship between current consumption and current income no longer existed. Because the impacts of the cyclical components, usually approximated by fluctuations in variables, were held to promote these empirical failures, it was believed that the inclusion of extra arguments that would capture the increased volatility in the cyclical components could significantly enhance the performance of these models in empirical research. For example, Hendry and von Ungern-Sternberg (1981) used liquid assets as proxies for wealth while Deaton (1977) used an inflation variable to portray possible price illusion on behalf of consumers. Subsequently, most leading macroeconomic models were modified to include these and other variables in their consumption functions.

Secondly, the development and understanding of more complicated econometric techniques provided more space to improve the performance of existing models. As a result of these, Deaton (1992) presents that 'It is a sobering undertaking to look back at many of the macroeconomic models of the time, and note the (now) obvious time-series problems: spurious correlations between integrated regressors, high coefficients of determination coupled with low Durbin-Watson statistics, and an almost complete lack of diagnostic testing.' [pp. 79]



For Hendry *et al* (1981), econometric techniques are vehicles to obtain information from raw data about the behaviour of economic variables<sup>4</sup>, while economic theory serves to provide a first approximation to empirical testing. Davidson *et al.*'s (1978) paper on consumption is revolutionary by involving such a method. They developed a conventional methodology for empirical modelling to formalize the standard procedures of co-integration analysis, dynamic models of error correction and others. Meanwhile, theoretical economists have censured the application of using econometric techniques for the purpose of developing empirical formulations that may perform well empirically but lack the support of any fit theoretical base. Despite this, the further understanding of econometrics has helped theorists in an important manner. Engle and Granger (1987) presented the co-integration and error correction analysis to establish a clear distinction between long-term and short-term dynamic statistical relationships between economic variables.

The third factor was a purely theoretical one. It evolved from the rational expectations revolution that was promoted by Lucas's (1976) critique concerning the structural relationships between variables. According to Lucas, the consumption function is one of those structural relationships that do not exist in the face of rational expectations. Under the theory of rational expectations, expectations are derived from all the available information relating to the true or actual governing behaviour of the variable to be predicted. Agents in the economy only perceive a structural relationship between permanent income and consumption, but the consumption functions developed above also assert that a structural relation between observed income and permanent income exists so that consumption would eventually be determined by observed current income. Consumption depends on current and expected future incomes. Instead Lucas argued that the relationship between past and expected future incomes cannot be properly treated as an invariant feature of the economic environment and is likely to change whenever changes in policy or other events cause rational agents to

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<sup>4</sup> Hendry's econometric principles are summarized in pages 29-31 of 'The Demand for M1 in the U.S.A., 1960-1988', Review of Economic Studies (1992)

change the way in which their past incomes affect their forecasts of future incomes. However, what does not change is the structural relationship between consumption and permanent income.

### 2.2.1 *The Rational Expectations Hypothesis (REH)*

The Rational Expectations Hypothesis (REH) has marked a “revolution in economic thinking that is comparable in the magnitude of its impact on the economics profession to the Keynesian revolution of a half century ago” (Schiller, p228) and forms a major part of the Rational Expectations Permanent Income Hypothesis (REPIH). But the REH is only one of a variety of strategies that have been used by researchers in modelling expectations. This part outlines the theory, and reviews both theoretical and empirical criticisms. After reviewing the model and the evidence, I want to see if the REH is the best available methods of modelling expectations at the micro level in the following chapter.

The premise of the REH is that economic variables are generated by systematic process. Over time, individuals will use all the information available<sup>5</sup> to them including previous expectation errors. Although individuals are not required to be always correct in expectation formation, they will recognize the inadequacies of their mechanism for expectation formation if it is systematically wrong and update the mechanism until correct on average. As a result, individuals should not make systematic errors.

To describe how the hypothesis works, we can imagine an economic variable  $Y$ , whose value is determined by its own lagged value, by the lagged value of other variables,  $X$ , and by an unexpected (random) shocks  $\varepsilon$  at time  $t$ . This provides us with the simple linear process:

$$Y_t = a + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \varepsilon_t \quad (2.1)$$

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<sup>5</sup> Information is used in the most optimal way and may change over time.

The expected values of  $Y_t$  is found by finding the mathematical expectation of  $Y_t$ . Since  $Y_{t-1}$  and  $X_{t-1}$  are lagged, their values are known at the end of period  $t-1$ . However, the value of  $\varepsilon_t$  only becomes known at the end of period  $t$ , so the rational forecaster must form some expectations of its value at the end of period  $t-1$ . This means that:

$$E_{t-1}(Y_t) = a + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + E_{t-1}(\varepsilon_t) \quad (2.2)$$

Where the random variable  $\varepsilon_t$  is assumed to be  $IID(0, \sigma^2)$ . The best estimate is made if the expected value of  $\varepsilon_t$  equal to zero. This leaves us with a formula for the expected value of  $Y$  as:

$$E_{t-1}(Y_t) = a + \beta_1 Y_{t-1} + \beta_2 X_{t-1} \quad (2.3)$$

Thus, the rational expectation of the variable  $Y$  in period  $t$  is its mathematical expectation given the available information.

It is noted that the REH does not claim that agents are always right in their expectations of future variables. In fact, the forecast error is exactly equal to the random variable that determines  $Y_t$ :

$$E_{t-1}(Y_t) - Y_t = \varepsilon_t \quad (2.4)$$

This random variable,  $\varepsilon_t$ , is uncorrelated with  $E_{t-1}(Y_t)$ , the predictions, and the other variables in the process and with the information set available to the agent. Otherwise it would logically be included in the initial expectations. Therefore, it must be correlated with  $Y_t$ , the actual realizations. Forecast

errors should have a mean value of zero and have the property of minimum variance<sup>6</sup>.

There are two types of rationality conditions, weak rationality and strong rationality. In the first condition, the expectation errors must be uncorrelated with historical information on prior realizations of the variable being forecast:

$$E_{t-1}(Y_t) - Y_t = \beta_1 Y_{t-1} + \varepsilon_t \quad (2.5)$$

Where  $Y_{t-1}$  is lagged values of  $Y_t$ . The coefficient  $\beta_1$  in the regression should not differ significantly from zero. Meanwhile, it is called strong rationality or full rationality if any other variables known to the economic agents must also be uncorrelated with the expectation errors.

### *Theoretical Analysis*

One of the main criticisms of the REH argues it is ambiguous that economic agents use the exact model used by economists who are capable of analysing the future general equilibrium of the economy. However, the fact of the matter is that the REH argues that economists and economic agents produce the same expectations but it does not argue that they come to that conclusion by using the exact same method. It is possible for economic agents to make reasonable predictions in the light of past observation and experience.

Another closely related criticism is the one that argues it is impossible to assume all decision-makers are intelligent enough to use and fully understand all the available information. But the hypothesis does not apply to every individual in the economy. Rather, it claims that on the average expectations are rational. The expectation in the market, on average, can possibly be rational even there are some agents may irrationally over-estimate or under-estimate. In fact, individuals can let other people form their expectations for

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<sup>6</sup> They have a variance less than that associated with any other model of forecasting. It also means that they are the most efficient means of forming expectations in a statistical sense.

them. These expectations are based on full information and are rational. One of example is the expectations of inflation constructed by the Central Bank or the Department of Finance. Thus, the expectations of the market as a whole can be rational without making the highly unlikely assumption that every single individual forms rational expectations.

A third criticism of the REH is that the necessary information is not available or very costly to use. But the REH does not claim individuals should know which variables are important in the generating process or know what the size of the coefficients in that process. Instead, it argues that, on average, economic agents will learn from past experience what the process is after a period of time. It is why the REH is best seen as a long-term argument. In fact, Friedman (1979, p.24) points out that a clear outline of economic agents' learning process to formulate expectations meeting the requirement is a missing part in the REH. But the absence of it does not take away from the hypothesis itself.

The fourth criticism of the hypothesis is that it has limited applicability. Rational expectations may not be possible to form because it is not easy to determine the variable generating process. However, Attfield, Demery and Duck (1985, p.28) present that a rational expectation can still be formed without knowing the exact process.

### ***Empirical Analysis***

Numerous empirical studies have been done to support or refute the rational expectations hypothesis since Muth published his seminal article (Muth, 1961). Much empirical work, such as Mishkin (1983), in the financial market and commodity exchanges has supported the REH. Although the results for these specialized markets are robust, it does not mean the hypothesis can hold truth across the economy. On the other side, if no major favourable insights of rational expectations in other markets have abounded, those empirical studies that have claimed to disprove the hypothesis have not been technically

strong. For example, Chow Test<sup>7</sup> has been used to test the REH by many economists but often their data fail to be consistent<sup>8</sup>. Also, Mullineaux (1978) found that results from Chow Test were always opposite to those from alternative testing methods.

Maddala, Fische, and Lahiri (1981), Gramlich (1983) and Batchelor (1986) tested the rationality of surveyed inflation expectations using the aggregated Michigan data. While these studies analysed quantitative questions about the future path of inflation (up/down/no change), the aggregation bias implies these individual rationality tests are not straightforward. Batchelor and Jonung (1989) examined micro-level data on respondents' subjective expectations using small Swedish panel data and over a short time period (twelve months) and found evidence of bias and inefficiency. Using latent variable models, Ivaldi (1992) rejected the hypothesis of rational expectation for the French manufacturing industry, while, Nerlove and Schuermann (1995;1997) used a similar model along with micro data from a sample of Swiss and UK firms, to reject the rational expectations hypothesis. The alternative hypotheses of adaptive and naive expectations are also rejected as well in these studies. Das *et al.* (1999) tested the rationality of income expectations using a relatively short Dutch dataset (1984-1988) and found that income expectations were on average too low relative to subsequent outcomes. However as has already noted, rationality may not to be required to average out over the course of only a single year. Indeed, Souleles (2001) argues that even five years might be too short a period to allow expectation errors to average out.

Furthermore, an interest in data derived from various household surveys and modelling the expectations of private households or individuals is increasing as economists consider decisions on consumption, savings, portfolio choice, investments in durable goods, labour supply, job search and fertility in many life cycle models. Guiso *et al.* (1992) and Domintz and Manski (1997) analyse Italian cross-sectional survey data on subjective income distributions and

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<sup>7</sup> This uses the F-test to test for structural stability in an econometric model.

<sup>8</sup> For the Chow Test to be accurate the consistency criterion must be met.

found that income uncertainty had a negative impact on the proportion of a households portfolio held in risky assets. Hochguertel (1998) found a similar result for the Netherlands. Alessie and Lusardi (1996) also used Netherlands panel data and found that while expected changes in income were significantly correlated with actual income changes, they did not find the expected negative relationship between savings and the predicted income change. Finally Das and Van Soest (1996) also used Dutch survey data to explain the relationship between expected income changes and previous income changes and the differences between income expectations and outcomes over the same time period. This found that many people are pessimistic about their future income prospects.

In short, there are many problems that arise in empirical work concerned with expectations. No overall conclusion about whether expectations in the market are rational can be obtained from empirical work as it is so imperfect. There is no sufficiently strong evidence to completely disprove this hypothesis until it has been empirically falsified. By now, rational expectations are the best available models for economists to use model economic expectations. They are efficient at a statistical level because they have an error term with a minimum variance and zero mean. Also the REH coincides perfectly with the concept of homo economicus<sup>9</sup> and of the utility-maximising individual. The main point of this section to be made is that the REH is not perfect but it is the best available method that we have for modelling expectations if these expectations need to be incorporated into economic models. At least, it fits the loose economic criterion of rationality.

Consequently, an unresolved methodological issue raised in the tests of the validity of the REH is if it is appropriate to test it at the micro level. Edward Prescott (1977) has argued that expectations are not observed directly, and economists cannot use survey data to test the REH. Instead, only some

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<sup>9</sup> It is a term used for an approximation or model of homo sapiens that acts to obtain the highest possible wellbeing for himself given available information about opportunities and other constraints, both natural and institutional, on his ability to achieve his predetermined goals.

theory incorporating the REH can be test if it is consistent with observations. On the contrary, a number of economists<sup>10</sup> have found that survey data on prediction variables can be of assistance in the empirical modelling of economic behaviour and econometric forecasting. Arnold Zellner (1985) supports the use of micro and industry data in examining relationships suggested by macroeconomic research, while Herbert Simon (1979) and James Tobin (1980) support direct empirical testing of the REH. My own view is that if the survey evidence supports the REH, results derived under this assumption will be both more interesting and more demanding of serious attention. As a result, it is an appropriate and worthwhile activity to direct test the REH at the micro level in this thesis.

### *2.2.2 Rational Expectations Permanent Income Hypothesis (REPIH)*

Hall (1978) considers the consumption function in terms of the Lucas' critique and attempts to formulate a simple empirical test of the idea that consumers maximize the expected value of their lifetime utility subject to an unchanging real interest rate. He argues that the possible structural relationship for consumption might not be based on the assumed relationship between current consumption and current income because this would not response to policy interventions and other shocks in the economy. Instead, the ordering of intertemporal preferences plays an important role. In other words, what does not change in the face of expectations is the agent's overall aim to maximize lifetime utility.

The foundations of Hall's work derive from the principles of utility maximization associated with the life-cycle/permanent income hypothesis that are then regarded as the most accurate applications of the theory of the consumer to the problem of dividing consumption between the present and the future. Thus consumers arrange their consumption on the basis of their expected lifetime income instead of their current income. His view is that the measurement of expectations and wealth play a central part in the permanent

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<sup>10</sup> Owen Sauerlander (1955); Otto Eckstein, Patricia Mosser, and Michael Cebry (1984)



income hypothesis. The major limitation of this in empirical studies is that permanent income and expected lifetime income or wealth cannot be directly observed. Friedman approximates permanent income as weighted average of current and past values of measured income with the help of the adaptive expectations hypothesis. Likewise, Hall's main objective is to examine the impact of the inclusion of forward-looking rational expectations and uncertainty on consumption behaviour. His exposition states that if agents are forward looking and have rational expectations, current consumption should only be related to the most recent period's consumption and that all other lagged variables should be irrelevant in predicting present consumption.

Hall (1978) considers a conventional life-cycle/permanent income model under uncertainty where household chooses a stochastic consumption plan to maximize the expected value of their time-additive utility function subject to an 'evolution of assets' budget constraint. The problem is to maximize

$$V(c_t, c_{t+1}, \dots, c_{t+T}) = E_t \sum_{\tau=0}^{T-t} (1 + \delta)^{-\tau} u(c_{t+\tau}) \quad (2.6)$$

subject to

$$\sum_{\tau=0}^{T-t} (1 + r)^{-\tau} (c_{t+\tau} - w_{t+\tau}) = A_t \quad (2.7)$$

where  $E_t$  denotes the mathematical expectations operator conditional on information available at time  $t$ ,  $\delta$  is the rate of subjective time preference,  $r$  is the rate of interest which is assumed to be constant over time ( $r \geq \delta$ ),  $c$  is consumption,  $A$  are assets apart from human capital,  $T$  is the length of economic life;  $u(\bullet)$  is the one-period utility function that is assumed to be strictly concave and  $w$  are earnings which are stochastic and the only source of uncertainty in this model.

The consumer chooses consumption  $c_t$  in each time period to maximize expected lifetime utility given all available information at that point. It is assumed that the consumer knows the value of  $w_t$  when choosing  $c_t$ . No specific assumptions are made about the stochastic properties of  $w$  except that the conditional expectation of future earnings given today's information exists. In particular, successive  $w_t$ 's are not assumed to be independent, nor is  $w_t$  required to be stationary in any sense.

To solve the above problem, Hall uses the Euler equation approach to describe the individual's behaviour. The advantage of this specification is that it removes the marginal utility of wealth from the model. Consequently, it is not necessary to explicitly model the distribution of future variables that could influence consumption choices. The Euler equation states that the expected utility lost from giving up a unit of consumption (the right-hand side) must be equal to the expected utility gained by consuming the proceeds of the extra saving at any future date. More generally, under standard assumptions associated with the permanent income hypothesis and rational expectations, including the absence of liquidity constraints and time separability, the Euler equation states that the marginal rate of substitution between current and future consumption,  $E_t u'(c_{t+1})/u'(c_t)$ , must equal their relative price given by the rate of interest and the rate of time preference,  $(1 + \delta)/(1 + r)$ . Therefore the rate of interest, individual's preferences (the shape of the agent's utility function and the rate of time preference), and unexpected events jointly determine individual's consumption plan. Furthermore, if the expectation is fully rational then only the interest rate and preferences affect the consumption plan. Following Deaton's (1992) argument [pp.25-9] the Euler Equation can be re-written as follows (arguments here follow Deaton, 1992, pp. 25-9)

$$\frac{(1 + r)E_t u'(c_{t+1})}{(1 + \delta)u'(c_t)} = 1 \quad (2.8)$$

The marginal utility functions are decreasing in the event of consumption under the assumptions about concave utility.

If we ignore the expectation operator, consumption will be growing when the interest rate is greater than the rate of time-preference and declining when the interest rate is less than the rate of time preference. If we consider the expectations operator and the level of uncertainty, the general results cannot be derived when interest rates and consumption are stochastic. If we assume utility functions are quadratic, that is marginal utility is therefore linear, and the real interest rate is non-stochastic, the results above can hold. Otherwise the concavity or convexity of the marginal utility function plays an essential role as well as the covariance between the interest rate and the marginal utility of money<sup>11</sup>. It is noted that interest rates also have a significant effect upon consumption and unanticipated changes in interest rates will move the consumption path up and down. Consequently, the theory provides no general result for the effects of changes in interest rates on current consumption.

Friedman (1957) makes an assumption that agents will consume a portion of their wealth stock without influencing their overall stock of wealth. It can be shown, by substituting the Euler equation when utility is quadratic into the budget constraint and rearranging, that the individual will consume  $1/(T-t)$  of his or her expected lifetime resources when the rate of interest is equal to the rate of time preference:

$$c_t = \frac{[A_t + \sum_{\tau=0}^{T-t} \{(1+r)^\tau E_t(w_{t+\tau}) - (\tau+1)(\frac{\delta-r}{1+r})c^*\}]}{T-t} \quad (2.9)$$

where  $c^*$  is the bliss level of consumption in the quadratic utility function  $u(c_t) = -1/2[(c^* - c_t)^2]$ .

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<sup>11</sup> The implications about the convexity and concavity of the marginal utility function are examined in more detail below.

### *Solutions to the Euler Equation and the Plausibility of the Assumptions Used by Hall*

Hall assumes that utility is quadratic and that the rate of interest is equal to the discount rate and these to derive the random-walk result that changes in consumption are white noise, and not related to anticipated changes in income and other variables that are in consumers' information set. This insight of Hall is often expressed in terms of the following Euler equation for consumer between period  $t-1$  and  $t$ :

$$c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t \quad (2.10)$$

where  $\varepsilon_t$  is unpredictable at  $t-1$  and can approximate closely the stochastic behaviour of consumption under the permanent income hypothesis<sup>12</sup>;  $\Delta$  is the first-difference operator taken with respect to time;  $Q_t$  includes variables such as age and changes in family size to capture shifts in tastes. Assuming utility takes the form of constant relative risk aversion, utility is now generally preferred,  $u(c) = c^{1-\rho}/(1-\rho)$ , where  $\rho > 1$  and denotes the coefficient of relative risk aversion. In this case,  $E_t(u'(c_{t+1})/u'(c_t)) = E_t(c_{t+1}/c_t)^{-\rho}$ . An approximation to this expression can be made by taking a (first-order) Taylor-series expansion around the point where consumption growth is zero.

Equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) is what we refer to as the basic REPIH and there are several important assumptions underlying it<sup>13</sup>. First, equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) is only a linear approximation of the exact Euler equation even under the assumption of constant relative risk aversion (CRRA) preferences. It can be shown that  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) implicitly assumes that the higher-order conditional moments of the

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<sup>12</sup> As Deaton (1992) states, the equation does not say anything about the variance of  $\varepsilon$ , and there is no reason to believe that the variance is constant. Hence, strictly speaking, equation (2.11) is not a random-walk.

<sup>13</sup> See Browning and Lusardi (1996) for a review and discussion of the issues.

expectation errors are orthogonal to variables in the information set by using a second-order Taylor series expansion on the marginal utility of consumption. Second, equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) is based on a utility function that is intertemporally separable in the sense that the marginal utility of consumption in period  $t$  depends only on the level of consumption in period  $t$ . As a result, it excludes behaviour arising from time nonseparable utility function such as habit persistence, catching up with the Joneses, disappointment and loss aversion, preferences that have been used with some success in explaining the equity premium puzzle in the finance literature<sup>14</sup>. Third, it assumes separability between consumption and leisure. Therefore, labour supply variables are absent from the Euler equation for consumption. Fourth, the real interest rate is subsumed in the constant  $\alpha$ . This is because although micro data have abundant information on consumers, the time period is rarely long enough to allow sufficient variations in the interest rate for an accurate estimate of the intertemporal elasticity of substitution. Finally, the capital market is assumed to be perfect in the sense that agents can freely transfer the desired amount of resources from one period to the next.

The economic implications of this equation are that the best prediction about the level of consumption in the next period is today's level of consumption. The disturbance term  $\varepsilon_t$ , unpredictable events at time  $t$ , leads to the divergences between the two levels of consumption. The result is consistent with rational expectations postulations despite changes in consumption being unpredictable. An agent informed rational expectations will use all available information relevant to the behaviour of consumption when in forming their expectations. Given the information available in period  $t-1$ , the agent at that time will set consumption at  $c_{t-1}$  which is equal to his or her estimate of his or her permanent income as shown in equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10). The right hand side of the equation gives

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<sup>14</sup> See, for example, Abel (1990) for the former two specifications, Epstein and Zin (1991) for the third.

that estimate of permanent income. A rational decision about consumption,  $c_{t-1}$ , would have taken account of all information regarding the evolution of  $w$  and  $r$  and the needs of the consumer described by the utility function and  $\delta$  available at time  $t-1$  and earlier. Since in period  $t-1$  the agent has consumed an amount equal to his/her permanent income, his/her stock of wealth ( $A_t + H_t$ ) in period  $t$  will be the same as it is at the beginning of  $t-1$  if agent does not receive new information about the future in period  $t$ . And so, in period  $t$  the consumer's estimate of his/her permanent income will be unchanged and he/she will set consumption,  $c_t$ , at the same level as before,  $c_{t-1}$ . In other words, consumption in period  $t$  would change only if new information becomes available between periods  $t-1$  and  $t$ . Because new information is defined to be unpredictable, it must be the case that consumption differs from lagged consumption only by an unpredictable element<sup>15</sup>. Hence, the disturbance term reflects information about the impact of all new information that becomes available to the consumer in period  $t$  about his/her lifetime wellbeing. The lagged consumption term contains all the past/predictable information. Hall argues that it is possible to derive an expression for that unpredictable element:

Evolution of non-human assets can be expressed by

$$A_t = (1 + r)(A_{t-1} - c_{t-1} + w_{t-1}) \quad (2.11)$$

and evolution of human wealth is present by

$$H_t = (1 + r)(H_{t-1} - w_{t-1}) + \sum_{\tau=0}^{T-t} (E_t w_{t+\tau} - E_{t-1} w_{t+\tau}) \quad (2.12)$$

So that the behaviour of the total wealth stock is given by the following equation:

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<sup>15</sup> Attfield, Demery and Duck (1991), pp. 208

$$A_t + H_t = (1 + r)(A_{t-1} - c_{t-1} + H_{t-1}) + \eta_t \quad (2.13)$$

where  $\eta_t = \sum_{\tau=0}^{T-t} (E_t w_{t+\tau} - E_{t-1} w_{t+\tau})$ . Then, the evolution of total wealth depends on the relationship between two informational variables,  $\eta_t$  and  $\varepsilon_t$ . By imposing quadratic utility or certainty equivalence, that relationship is given by:

$$\varepsilon_t = \left[ 1 + \frac{\lambda}{1+r} + \dots + \left( \frac{\lambda}{1+r} \right)^{T-t} \right] \eta_t = \alpha \eta_t \quad (2.14)$$

This is according to Hall ‘the modified annuity value of the increment in wealth. The modification takes account of the consumer’s plans to make consumption grow at a proportional rate  $\lambda$  over the rest of his life’. (pp. 975-6)

All the Euler equation results discussed above still apply. The consumption equation is simply a stochastic generalization of the simplest life-cycle model in which consumption is constant over life with (predictable) variations in income, which is offset by appropriate asset transactions.

However, the economic implications of this solution to the Euler equation and the Euler equation itself must be taken into perspective for the following assumptions:

- i. Consumption is the only argument in the consumer’s utility function.
- ii. Capital markets are perfect so that consumers can borrow/lend without any restrictions at a constant rate of interest as long as the present value of their consumption does not exceed the present value of their human and financial wealth (this means that there are no non-linearity in the budget constraint),
- iii. The rate of time preference does not exceed the rate of interest,

- iv. Certainty equivalence is assumed by Hall
- v. There are no habits or adjustment costs,
- vi. The consumption of non-durable goods is the only goods considered.
- vii. There are no measurement errors or transitory shocks to consumption
- viii. The coincidence of the frequency of consumers' decision making with the observation period of the data,
- ix. Infinite lifetime

The first two assumptions infer that rational agents can substitute between current and future expenditures to achieve the maximum level of lifetime utility without any difficulties. The ability to borrow and lend makes the optimal consumption plan independent of current income under certainty. Current income would affect consumption path in a rational expectations-permanent income framework with certainty equivalence only through its unpredictability represented by the error term in the consumption equation. This explains why consumption plans are independent of the level of current income and only depend on the preferences, the rate of interest faced by the consumer and unforeseeable events. Note that the second assumption implies that consumers do not face any type of liquidity constraints. But more and more economists have relaxed this assumption to allow for the possibility that consumers may be liquidity constrained in their theoretical and empirical work. This can be taken to mean that consumers are denied credit altogether or that they cannot borrow as much as desired<sup>16</sup>.

The third assumption describes the patient nature of consumers. Since if consumers are assumed to be strongly impatient and their incomes are known with certainty, they would consume more than their current income and go into debt. Under this assumption, the consumers are to be willing to accumulate wealth in the form of savings. Without this assumption, agents

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<sup>16</sup> Consumers whose cost of borrowing is higher than the return to saving can also be viewed as liquidity constrained, but this channel is not being considered here because the real interest rate is assumed constant.



would undertake too high levels of consumption in their early life under certain income process or under certainty equivalence.

The certainty equivalence assumption is helpful in solving the Euler equation. The presence of uncertainty and the resulting expectation operator cause the main difficulty associated with solving the Euler equation. We can solve this problem by passing the operator through the equation with the assumption that marginal utility functions are linear, such as certainty equivalence assumption. Therefore, this is a very powerful assumption made on the face of Jensen's inequality, which says that the expected value of the function is not (in general) equal to the function of the expected value<sup>17</sup>. The actual shape of the indifference curve, whether it is concave up or concave down<sup>18</sup>, determines the direction of error and the nature of the result. If the function is a convex marginal utility function, then the marginal value of consumption is higher when consumption is low and the increasing marginal rate with decrease in consumption should be greater when consumption is low than when it is high. If the function is a line, in which case the second derivative is zero, there is no error between expected value of function and the function of expected value. Accordingly, a linear marginal utility function rules a precautionary motive in consumer's behaviour.

#### *Deviations from Quadratic Utility (Certainty Equivalence)*

In this section, some work on the relaxation of the quadratic utility function assumption is reviewed. Based on Pratt (1964), Arrow (1965), Leland (1968) and Rothschild and Stiglitz (1970;1971), Kimball (1990) develops a simple 2-period framework. He presents the two-period maximization problem as follows (pp. 59)

$$\max_c u(c) + Ev(w - c + \tilde{y}) \quad (2.15)$$

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<sup>17</sup> Jensen's inequality tells us that convex (concave) marginal utility, the expectation of the function is greater (Tversky *et al.* 1991) than the function of the expectation.

<sup>18</sup> It can also be described in terms of the second derivative of the function that measures the curvature.

where  $u$  is the first period utility function,  $v$  is the second period utility function,  $c$  is first period consumption,  $w = w_0 + \bar{y}$  where  $w_0$  is the consumer's initial assets,  $\bar{y}$  is the expectation of second period income, and  $\tilde{y}$  is the risky component of second period income, such that  $y = \bar{y} + \tilde{y}$ . The first order condition is

$$u'(c) = Ev'(w - c + \tilde{y}) \quad (2.16)$$

Since the risky component of second period income,  $\tilde{y}$ , has an impact on marginal utility in the second period and disarrays the first order condition consequently, consumption in the first period would be affected as a result. If we define savings as  $s = w - c$  the first order condition can be re-written as:

$$u'(c) = Ev'(s + \tilde{y}) \quad (2.17)$$

Following Pratt (1964), Kimball defines the following concepts (pp. 59):

- 1) If a quantify  $\psi^*$ , which is called the compensating precautionary premium, exists that satisfies  $u'(w - c) = Ev'(w - c + \tilde{y} + \psi^*)$  and thus compensates for the effect of the risk  $\tilde{y}$  on second-period expected marginal utility then first-period consumption will be unaltered by the addition of the risk and the compensating precautionary premium; and
- 2) If a quantity  $\psi$ , which is called the equivalent precautionary premium, exists that satisfies  $v'(w - c - \psi)Ev'(w - c + \tilde{y})$ , then the elimination of the risk  $\tilde{y}$  at the cost to the consumer of the certain quantity  $\psi$  will leave optimal first-period consumption unchanged.

Kimball suggests that  $\psi$  and  $\psi^*$  are 'approximately equal "in the small"'. Also, nearly all important qualitative results about equivalent risk premiums are convertible with corresponding results about compensating risk premium. Moreover, due to the close resemblance between the risk premium and the precautionary premium 'one can be confident that a result about equivalent

precautionary premium will imply a corresponding result about compensating precautionary premium.'

Kimball indicates that  $u'(c)$  can be ignored in the definition of precautionary premium for the model where marginal utility is constant for a fixed value of the decision variable  $c$ . Kimball then clarifies that the analogy between the theory of precautionary saving and the theory of risk aversion is particularly simple. He shows that the role of the negative of marginal utility,  $-v'$ , for precautionary saving is the same as the utility function for risk aversion. For instance, risk aversion is given by the concavity of  $v$ , whilst a positive precautionary saving motive is shown by the concavity of  $-v'$  (i.e.  $v'''(\bullet) > 0$ ). Another example is that the index of absolute prudence in this model represents the strength of the precautionary saving motive, which can be present if:

$$\eta(w, c) = \eta(s) = -\frac{(-v'(s))''}{(-v'(s))'} = -\frac{v'''(s)}{v''(s)} \quad (2.18)$$

Thus, because the third derivative of the utility function is different from zero, deviations from quadratic utility can lead to a precautionary saving motive although it is noted that these results only apply for a given level of wealth in this two-period model. In 1996, Carroll and Kimball extend this framework to a multi-period model to show that the precautionary saving Kimball investigated in his two-period model can come about at different levels of wealth and consumption.

A number of studies have tried to explore the impact of relaxing the quadratic utility function assumption on consumer behaviour. In the early studies, most economists relax the quadratic utility assumption on the basis of the Euler equation 
$$\frac{(1+r)E_t u'(c_{t+1})}{(1+\delta)u'(c_t)} = 1 \quad (2.8), \text{ except for Caballero}$$

(1990) who explored the consumption function in terms of CARA preferences. Hansen and Singleton (1982) and Skinner (1988) first tested the

Euler equation under the assumption of CRRA preferences. If preferences are CRRA,  $u(c_t) = c_t^{1-\rho} / (1-\rho)$ , the Euler equation is given by

$$E_t\left(\frac{1+r_{t+1}}{1+\delta} c_{t+1}^{-\rho}\right) = c_t^{-\rho} \quad (2.19)$$

so that if we define the following quantity  $z_{t+1}$  as

$$z_{t+1} = \frac{1+r_{t+1}}{1+\delta} c_{t+1}^{-\rho} - c_t^{-\rho} \quad (2.20)$$

then according to rational expectations theory, any variable, say  $w_j$ , which is dated at time  $t$  or earlier, should be orthogonal to  $z_{t+1}$ :

$$\frac{1}{T} \sum_{t=1}^T w_j z_{t+1} = 0, \quad j = 1, \dots, J \quad (2.21)$$

where  $J$  denotes the number potential instruments in the consumer's set. In Hansen and Singleton's work, data on non-durables consumption, services, treasury bill rates, and the return on New York Stock Exchange stocks were used to find that the Euler equation can be rejected when equation

$$\frac{1}{T} \sum_{t=1}^T w_j z_{t+1} = 0, \quad j = 1, \dots, J \quad (2.21) \text{ is estimated using GMM.}$$

Browning and Lusardi (1996) review most of the empirical evidence on the Euler equation and precautionary motive savings at the micro level. They argue that the evidence on the validity of the Euler equation using the orthogonality condition discussed above is 'deeply ambiguous' (pp. 1835). How to construct an observable and exogenous measure of risk that varies across the population (pp. 1835-6)<sup>19</sup> become an open problem on the face of such ambiguity in all the studies examining precautionary savings. Most of the

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<sup>19</sup> Even Browning and Lusardi disagree on the evidence (pp. 1835).

variables which are chosen to proxy risk along with the corresponding strengths and weakness are thoroughly discussed in their paper. In addition, they also review the evidence on the precautionary savings. Thus while some studies find little or no evidence to support the presence of a precautionary motive, others claim that such a precautionary motive can explain a large proportion of wealth holdings of household.

### 2.2.3 Failure of the REPIH

In summary, Hall's REPIH states that changes in consumption reflect the new information that becomes available to a consumer, that consumption changes are unpredictable because this new information is unpredictable by nature and because this new information is immediately processed by the consumer. The first tests of the REPIH, which are known as orthogonality tests, introduces lagged variables other than lagged consumption to the martingale equation. With respect to equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) if lagged consumption alone is sufficient to predict current consumption then no other lagged variables can have statistically significant coefficients when they are included in the models. Hall (1978) provides some empirical evidence to support his theory, as he finds that the change in consumption is independent of lagged income. Although, in his work, he also finds lagged stock prices also had a significant influence current consumption. However he dismisses this latter finding he arguing that it is not unreasonable to approximate consumption by a random-walk process when stock prices themselves are supposed to follow such a random-walk as well.

However, the REPIH turned out to be controversial especially in consumption research where, the years, several empirical investigations indicated the existence of patterns of excess sensitivity of consumption to lagged income over the life cycle. Using large macroeconomic models to forecast the economic behaviour associated with the assumptions of the rational expectations framework, most applied consumption research refuted

the random-walk prediction for consumption at the aggregate level. Hence economists like Flavin (1981), Hall and Mishkin (1982), Campbell and Mankiw (1989) found that aggregate data suggested consumers did not smooth out their consumption as much as predicted by the Life Cycle or the Permanent Income Hypothesis (LC/PIH), and had, instead, consumption reacted too strongly to changes in current income. This is known as the excess sensitivity. If expectations are rational then Hall's permanent income hypothesis can be refuted since the claim that changes in consumption are unpredictable is not fulfilled. According to the random-walk equation, only unpredictable changes in actual income can affect consumption, so consumption should not react too strongly to actual and past income changes<sup>20</sup>.

#### *2.2.4 Some Explanations for the Failure*

In view of the above results which suggest the existence of 'excess sensitivity' and the failure of economic agents to smooth their consumption, many economists have examined the possible reasons for the failure of the REPIH. This section reviews some of the most important explanations.

##### ***Private Information***

Campbell (1987) considers the possibility that different information sets are used by agents and researchers to make predictions about changes in permanent income from labour and capital income. He develops a model of savings under the REPIH to account for such a possibility, which shows that such an information discrepancy can lead to problems for excess smoothness tests but not for excess sensitivity tests which examine the significance of past income for making forecasts about changes in consumption.

Excess smoothness tests are subject to this information discrepancy because they are based on expectations about future income. However, such

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<sup>20</sup> The predictability component depends on the nature of the income process so that if income follows a unit root the predictable component carries over to the future.

predictions about future income and respective permanent income are likely to differ between the econometrician and the agent if the information sets they use are different from each other. Hence any predictions about the volatility of permanent income that emanate from the predictions made by the econometrician about future labour income might not represent the actual behaviour of the representative agent.

Campbell (1987) and Campbell & Deaton (1989) develop models that could account for this informational discrepancy. In order to forecast labour income and hence permanent income, they examine the (superior) information that is conveyed by savings. The principle used in those papers is that: agents will reduce the amount of consumption at  $t$  if they expect lower future incomes and therefore a lower permanent income at time  $t$ . Such a reduction in consumption will induce an increase in saving that is defined as the difference between current income and consumption. As a result, savings provide information about agents' expectations about future labour income. This relationship can be expressed by the following equations<sup>21</sup>:

$$c_t = y_t^p = r \left[ A_t + \sum_{i=0}^{\infty} \rho^{1+i} E_t y_{t+i} \right] \quad (2.22)$$

$$s_t \equiv y_t + rA_t - c_t \quad (2.23)$$

Substituting  $c_t = y_t^p = r \left[ A_t + \sum_{i=0}^{\infty} \rho^{1+i} E_t y_{t+i} \right]$  (2.22) into

$s_t \equiv y_t + rA_t - c_t$  (2.23) and rearranging yields

$$s_t = - \sum_{i=1}^{\infty} (1+r)^{-i} E_t \Delta y_{t+i} \quad (2.24)$$

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<sup>21</sup> Here  $y$  is labour income and corresponds to  $w$  and  $A$  are assets and correspond to  $y^k$  in the previous analysis.

Hence, as savings equal the expected present value of future declines in labour income, therefore savings will rise (fall) if future labour income changes are revised downwards (upwards). This equation is referred to as the ‘savings for a rainy day’ aspect of the permanent income hypothesis, and can help overcome the information discrepancies mentioned earlier. Taking the savings equation:

$$s_t = -\sum_{i=1}^{\infty} (1+r)^{-i} E_t(\Delta y_{t+i} | I_t) \quad (2.25)$$

where  $I_t$  denotes the agent’s information set at  $t$ . If  $H_t$  is the econometrician’s information set at  $t$ , and it is assumed that

$$H_t \subseteq I_t$$

then the agent’s information set encompasses the one used by the econometrician. It is also assumed that the econometrician observes the current saving decision of the consumer, so that savings are a part of  $H_t$ .

This is the crucial assumption that is needed to overcome the superior information problem. Given those two assumptions, taking the expectations

$$\text{of } s_t = -\sum_{i=1}^{\infty} (1+r)^{-i} E_t \Delta y_{t+i} \quad (2.24) \text{ conditional on the}$$

information set  $H_t$ :

$$E(s_t | H_t) = -\sum_{i=1}^{\infty} (1+r)^{-i} E(E(\Delta y_{t+i} | I_t) | H_t) \quad (2.26)$$

which, by the ‘law of iterated expectations’ and the two assumptions above, is equal to

$$s_t = -\sum_{i=1}^{\infty} (1+r)^{-i} E(\Delta y_{t+i} | H_t) \quad (2.27)$$



so that the econometrician's information set is used instead of the agent's. The crucial assumption here is that savings are observed by the economist allowing them to bridge the gap between his/her information set and the information set of the agents.

From the 'savings for a rainy day equation', it follows that

$$s_t - \Delta y_t + (1+r)s_{t-1} = -r\varepsilon_t \quad (2.28)$$

$$\varepsilon_t = \left( \frac{1}{1+r} \right) \sum_{i=0}^{\infty} \left( \frac{1}{1+r} \right)^i [E_t y_{t+i} - E_{t-1} y_{t+i}]$$

Equations  $s_t - \Delta y_t + (1+r)s_{t-1} = -r\varepsilon_t$  (2.28) and

$s_t \equiv y_t + rA_t - c_t$  (2.23) summarize the testable implications

of the permanent income hypothesis and are exploited in papers by Campbell (1987) and Campbell & Deaton (1989). Testing for the validity of the REPIH using  $s_t - \Delta y_t + (1+r)s_{t-1} = -r\varepsilon_t$  (2.28) is more powerful

than using equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) as

long as the data do not invalidate the intertemporal budget constraint

$s_t \equiv y_t + rA_t - c_t$  (2.23).

The saving equation  $s_t = -\sum_{i=1}^{\infty} (1+r)^{-i} E_t \Delta y_{t+i}$  (2.24) is also

important from a statistical and econometric point of view as it allows us to test the permanent income hypothesis through  $s_t - \Delta y_t + (1+r)s_{t-1} = -r\varepsilon_t$  (2.28). Assume that labour income is stationary after taking first differences.

Then equations  $c_t = y_t^p = r \left[ A_t + \sum_{i=0}^{\infty} \rho^{1+i} E_t y_{t+i} \right]$  (2.22),

$s_t \equiv y_t + rA_t - c_t$  (2.23) and  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow$

$\Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) are also stationary in first differences, but

savings<sup>22</sup> is stationary in levels. From the cointegration literature equation  $s_t \equiv y_t + rA_t - c_t$  (2.23) and the fact that savings are stationary, consumption is a random-walk, and total disposable income is stationary after first differencing, then it must be the case that a linear combination of consumption and income exists so that both variables are cointegrated. By Engle and Granger's theorem, an 'error correction mechanism' between the cointegrated variables exists which enables 'to put it into *VAR* form by dropping one of the elements of  $\Delta x_t$  (where  $x_t = [y_t, A_t, c_t]'$ ) and replacing it with  $a'x_t$ . [...] The resulting model is well-behaved and has the property of cointegration without the restrictions on the *VAR* coefficients' [Campbell 1987, pp. 1256]. Accordingly, one can test the REPIH as a set of restrictions on a vector autoregression for changes in labour income and savings. Campbell exploits this characteristic of cointegration and proposes a *VAR* system of labour income innovations and savings (which is obtained by rewriting the ECM into *VAR* as mentioned above) to test the REPIH.

Campbell, Campbell and Deaton for the US and Attfield *et al.* (1990) for the UK showed that the data does reject the appropriate restrictions imposed on the *VAR* thereby implying that the permanent income hypothesis is flawed<sup>23</sup>. However Muellbauer and Murphy (1993) debate the superior information finding by arguing that lagged saving has an insignificant negative effect on subsequent income for the UK economy.

West (1988) also investigated the problem of inferior information. By considering a variance bounds test, he examined the sensitivity of consumption under the hypothesis that income has a unit root. West tested to see whether the results in Flavin's permanent income hypothesis model varied if consumers were allowed to use additional information than that conveyed

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<sup>22</sup> Intuitively, saving is a discounted present value of changes in expected labour income. These changes must be stationary for otherwise they could be predicted.

<sup>23</sup> The test demonstrates that there is excess smoothness and that the orthogonality condition (when lagged income is introduced) is breached.

by lagged and current labor income for predictions about their permanent income. If we denote the consumer's and the observer's information sets by  $I$  and  $H$  respectively, Flavin's model implies

$$c_t - Ec_t | I_{t-1} = \Delta c_t = y_{it} - Ey_{it} | I_{t-1} \quad (2.29)$$

where  $y_{it} = r(1+r)^{-1} \sum_{j=0}^{\infty} (1+r)^{-j} Ey_{it+j} | I_t$ .

Thus  $\text{var}(\Delta c_t) = E(y_{it} - Ey_{it} | I_{t-1})^2 \equiv \sigma_I^2$ . If only current and past income observations are used by the econometrician, then the observer can only hope for

$$\sigma_H^2 = E(y_{HT} - Ey_{HT} | H_{t-1})^2$$

So that, unless  $H_t = I_t$ ,  $\text{Var}(\Delta c_t) \neq \sigma_H^2$ ; and it is likely that  $\sigma_H^2 \geq \sigma_I^2 = \text{var}(\Delta c_t)$ . This implies that the variance of an econometrician's estimates is greater than the variance of the consumers estimate. In other words, because economists have less information than required to make forecasts which resemble those of the agent's, excess smoothness results.

West is able to work out the difference between  $\sigma_H^2$  and  $\sigma_I^2$  by using the intertemporal budget constraint  $s_t \equiv y_t + rA_t - c_t$  (2.23), and introduces another test for the permanent income hypothesis;

$$\sigma_H^2 = \sigma_I^2 + [(1+r)^2 - 1] \text{var}(y_{it} - y_{itH})$$

or

$$\sigma_H^2 = \text{var}(\Delta c_t) + [(1+r)^2 - 1] \text{var}(c_t - rA_t - y_{itH}) = \sigma_{\Delta c}^2 + \sigma_v^2 \quad (2.30)$$

Under the permanent income hypothesis, these equations must be true. If consumers use more information than that conveyed by current and lagged income, then  $\sigma_v^2$  must be statistically different from zero. If the permanent income hypothesis is true then  $\sigma_H^2 - \sigma_{\Delta c}^2 - \sigma_v^2$  must be zero.

West's finding rejects the null hypothesis  $\sigma_H^2 - \sigma_{\Delta c}^2 - \sigma_v^2 = 0$  at the 5% level and the null  $\sigma_H^2 - \sigma_{\Delta c}^2 - \sigma_v^2 = 0$ . This implies that the 'insensitivity of consumption to news about income is unlikely to result purely from the use by the consumer of additional variables to forecast income' [pp. 23]. West adds wealth shocks and transitory consumption into this model to explain the insensitivity by introducing.

### ***Variable Interest Rates***

Campbell and Mankiw (1989) relax the assumption of a constant interest rate made in the permanent income hypothesis and replace it with a varying and uncertain real interest rate. They examine two models of the Euler equation: the first considers a single forward-looking rational agent who consumes his or her permanent income; while the second model assumes a proportion of consumers in the economy are reluctant to substitute consumption intertemporally in response to interest rate movements. Because the error term in the Euler equation may be correlated with the independent variables in the regression, they use instrumental variables to estimate both models. It can be considered as a restricted pattern of a more general equation system, in which both the dependent and independent variables are regressed directly on the instruments, to estimate the REPIH by instrumental variables where the independent variables are current income innovations and the interest rate. The martingale equation places over-identifying restrictions on the systems of equations when there is more than one instrument. Those restrictions are used to test the permanent income hypothesis.

### *Permanent Income Consumers*

According to Campbell and Mankiw (1989), the log-linear generalization of the consumer's Euler equation that accommodates variable interest rates is shown by:

$$\Delta c_t = \mu + \sigma r_t + \varepsilon_t \quad (2.31)$$

The rate of interest  $r_t$  is contemporaneous with the changes in consumption at time  $t$ , which is assumed to be uncorrelated with lagged variables but to be correlated with the error term in this condition.  $\sigma$  is defined as the intertemporal elasticity of substitution and should capture the fact that high *ex ante* real interest rates lead to rapid consumption growth.

However, using instrumental variables to estimate this equation lead to disappointing results. As a result Campbell and Mankiw gave a number of reasons for why the above equation one is probably misspecified [pp. 198-200]:

1. The hypothesis that consumption growth is unpredictable is rejected at the 5% level or better, which is inconsistent with Hall's (1978) interpretation of the data. If the REPIH were true, and  $\sigma$  were zero, consumption should be a random-walk. Furthermore, the over-identifying restrictions of this equation are rejected at the 5% level or better whenever lagged real interest rates are included in the set of instruments.
2. The estimates of  $\sigma$  are highly unstable and small unless the nominal interest rate used as the instrument exceeds one.
3. Reversing the Hall regression yields estimates for  $\frac{1}{\sigma}$  that are not as large as would be predicted by the REPIH.

Campbell and Mankiw suggest that this misspecification of the model is due to the exclusion of rule-of-thumb consumers.

### ***Rule-of-Thumb Consumers***

As a result, a more general model is then considered, in which a fraction  $\lambda$  of agents in the economy, the rule of thumb consumers, consume their current income, and the remainder behave according to equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow$

$\Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10). The following model is estimated by instrumental variables

$$\Delta c_t = \mu + \lambda \Delta y_t + \theta r_t + \varepsilon_t \quad (2.32)$$

where  $\theta = (1 - \lambda)\sigma$ . The two coefficients we interest are now  $\lambda$ , the proportion of rule of thumb consumers, and  $\theta$ , the effects of interest rates on consumption. By estimating this equation Campbell and Mankiw found a number of interesting implications. Firstly, rule-of-thumb consumers appear to exist in the US economy since the coefficient of current income is substantial and statistically significant. Secondly, they found evidence that *ex ante* real interest rate is not in any way determining the amount of consumption growth. The coefficient  $\theta$  is small and indicates that the intertemporal elasticity of substitution for the permanent income consumers is small as predicted by the theory. Finally, the robustness of these results is enhanced by the fact that the over-identifying restrictions are never close to being rejected.

These results suggest that the expected changes in consumption depend on expected changes in income because rule-of-thumb consumers exist in the economy. This may explain why the excess sensitivity phenomenon occurs and suggests that using a single representative agent to explain the behaviour of aggregate consumption is not entirely correct.

### ***Liquidity Constraints***

Deaton (1991) examines the nonlinearities in the intertemporal budget constraint associated with borrowing constraints in a model where agents face

uncertain income and are allowed to be both ‘impatient’<sup>24</sup> and prudent at the same time<sup>25</sup>. On the condition that precautionary motives interact with liquidity constraints, facing income uncertainty, even impatient consumers have an additional incentive to accumulate assets when times are good because of their inability to borrow when times are bad. Deaton shows that the consumption profile under this framework is dependent on the time-series behaviour of income.

Hall’s problem<sup>26</sup> is modified with assumptions of convex marginal utility, borrowing constraints and impatient consumers. To solve the Euler equation easily, Deaton specifies the framework by introducing the term ‘cash in hand’ which acts as the state variable. The familiar Euler Equation is changed with the introduction of the borrowing constraints:

$$\lambda(c_t) = \max \left[ \lambda(x_t), \frac{1+r}{1+\delta} E_t \lambda(c_{t+1}) \right] \quad (2.33)$$

where  $\lambda$  denotes marginal utility and  $x$  is cash in hand defined as  $x_t = A_t + y_t$  and  $\frac{1+r}{1+\delta} = \beta < 1$ . Since consumers are not allowed to spend more than their cash in hand, no borrowing is permitted in the current period<sup>27</sup>. The solution to the problem is difficult to obtain because the marginal utility function  $\lambda$  is nonlinear. In order to proceed, Deaton changes the problem to look for a stationary stochastic optimum in which consumption is a function of the state variable  $x_t$ ,  $c_t = f(x_t)$ . The marginal utility of money is defined for this purpose as

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<sup>24</sup> The rate of time preference is greater than the rate of interest.

<sup>25</sup> They have a convex marginal utility function.

<sup>26</sup> Here we show the modification associated with an i.i.d. income process.

<sup>27</sup> The constraint implies that consumption cannot be higher than cash in hand, so given the convexity of the marginal utility function, that cannot be lower than  $\lambda(x_t)$ . If  $\lambda(x_t) > \beta E_t \lambda(c_{t+1})$ , the constraint will bind; otherwise with no liquidity constraints, the two marginal utilities are equated as agents seek to equate marginal utilities across time.

$$p(x_t) = \lambda[f(x_t)]$$

or

$$c_t = \lambda^{-1}[p(x_t)] \quad (2.34)$$

This enables the Euler equation to be written as

$$p(x_t) = \max[\lambda(x), \beta \int p\{(1+r)(x - \lambda p(x) + y)\} dF(y)] \quad (2.35)$$

Labor income becomes the only source of uncertainty after expectations have been taken into account in this framework. Consequently, the marginal utility of money today equates to the maximum value of either the marginal utility of cash in hand in the constrained situation or the discounted expected value of future marginal utility of money. The solution to this equation is then used to characterize the equilibrium properties of the marginal utility of money and thus the policy function  $f(x)$ . The solution is obtained (pp. 1227) with the specification of an updating rule used for a finite number of periods

$$p_n(x_t) = \max[\lambda(x), \beta \int p_{n-1}\{(1+r)(x - \lambda p_n(x) + y)\} dF(y)] \quad (2.36)$$

and with the backward iteration of the functions  $p_0(x), p_1(x), \dots, p_n(x)$  until the function converges. In this problem,  $n=0$  is the last period where everything is spent  $p_0(x) \equiv \lambda(x)$  if there are no bequests. The period before that,  $n=1$ ,  $p_1(x)$  is determined by either the borrowing constraint or marginal utility. The problem is solved recursively. This modified problem has the following properties ‘the convexity of  $\lambda(x)$  implies  $p(x)$  is convex. [...] With borrowing constraints, the convexity of  $p(x)$  determines the degree of precautionary savings. Moreover  $p(x)$  is more convex than  $\lambda(x)$ , so that the inability to borrow in adversity reinforces the precautionary motive’ [pp.



1227]. Deaton shows that for independently and indistinguishably distributed income there is a unique  $x^*$  such that:

1.  $c = f(x) = x$  when  $x \leq x^*$  and,
2.  $c = f(x) \leq x$ , when  $x \geq x^*$ .

The implications are that the agent will spend everything and no assets are accumulated if the total value of assets and income is below the critical level  $x^*$ , given a level of assets and a draw of labour income. If the amount of cash in hand,  $x$ , is greater than the critical value, something will be held over and a new positive level of assets will be carried forward to be added to next period's income.

Some characteristics of the solution are summarized as follows:

1. The distribution of consumption will not be symmetric; the consumer can prevent consumption from being high but cannot prevent it from being too low.
2. The evolution of marginal utility of money  $p(x)$  is a martingale in the standard case, but under borrowing restrictions it follows a renewal process i.e. as long as the consumer carries forward positive assets, we have the martingale result, but as soon as the assets fall to zero, the process loses its memory and starts again.
3. The level of  $x^*$  and therefore the amount of smoothing are also determined by the coefficients  $\rho$ <sup>28</sup> (which) and  $\sigma$ <sup>29</sup>.

The results change slightly when the income process is serially correlated but stationary. Income  $y$  now becomes the state variable together with  $x$  since both convey information about future consumption decisions. Consumers' behaviour is similar to the previous case: an amount  $x^*$  exists whereby levels

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<sup>28</sup> It is the coefficient in the isoelastic utility function  $u(c) = c^{-\rho}$  and represents prudence.

<sup>29</sup> It is the variance of the income process and therefore represents uncertainty.

of  $x$  below it lead to all cash in hand to be consumed and levels of  $x$  above  $x^*$  lead to a proportion of the consumer's cash in hand to be saved for future periods. The actual level of  $x^*$  depends on the arguments given above, but this time also depends on the level of income, or the 'state'.

Some characteristics of the solution for serially correlated stationary income are summarized as followed:

1. Consumption is smoother than income, but the distribution of consumption is still asymmetric. Savings are a much more effective cushion against high consumption than against low consumption.
2. The coefficient of the AR process plays an important role.

When the income process is nonstationary, the analysis is modified to make all the variables<sup>30</sup> in the problem stationary. To achieve this, Deaton divides all those variables by the level of income. The solution is given in terms of these new variables using the same techniques. The implications for consumption behaviour when the income process is nonstationary are as followed:

1. In the case of the no serial correlation, a variable  $w^* = \frac{x_t^*}{y_t}$  exists such that when  $w < w^*$ , assets will remain at zero; for  $w > w^*$  the evolution of assets is more difficult to follow although it can be shown by simulations that  $w$  will eventually decline below  $w^*$  in finite time and therefore assets will eventually become zero so that all income is consumed. When income is a random-walk and borrowing constraints are present, smoothing is not desirable: if income is above average it is expected to continue that way, so the additional income enables the consumer to get closer to the ideal level of consumption. When a fall in income occurs nothing can signal to the agent when the future trough in income will

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<sup>30</sup> Income, cash in hand and consumption

occur in order to allow them to smooth their consumption. In consequence, the combination of ‘the persistence of the random-walk and the binding liquidity constraints precludes the accumulation of assets’. [pp. 1238]

2. For the serially correlated case, a solution to the problem can be obtained by simulations. Deaton finds that as soon as a bad state is announced, savings switch from zero to positive and the consumer begins to accumulate assets. As the slump continues, the savings ratio stops rising and falls below zero if the slump is long enough. Assets go on rising for a while after the savings ratio has started falling, but eventually reach a ceiling above which they cannot go. At this point, the negative savings ratio and asset income help protect consumption against the effects of income which has negative expected growth over the slump. Finally the slump ends and the boom takes over. As this happens the consumer uses all their accumulated assets to finance a spending boom and spends the boom with consumption equalling income. However, while this result is the exact opposite of that implied by the permanent income hypothesis, it does not appear to be supported by the data. Deaton dismissed this point by arguing that ‘even in the absence of borrowing restrictions, conditions for aggregation to representative agents are implausible, so that a representative agent formulation is perhaps even more than usually misdirected when there are liquidity constraints’. [pp. 1241] This clearly opens the debate about aggregation in a representative agent framework.

### ***Excess Sensitivity***

Flavin (1993) considers an alternative specification to the REPIH where consumption exhibits excess sensitivity to current income<sup>31</sup>. With the

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<sup>31</sup> In this section we concentrate on the theoretical aspects of Flavin’s paper. In chapter 6 we concentrate on the econometric aspects.

assumption that an individual will consume all of its permanent income and a proportion  $\beta$  of its transitory income each period, Flavin argues that liquidity constrained individuals show excess sensitivity to their current consumption:

$$c_t = y_t^p + \beta y_t^T \quad (2.37)$$

where  $0 < \beta < 1$  and permanent income is defined by

$$c_t = y_t^p = r \left[ A_t + \sum_{i=0}^{\infty} \rho^{1+i} E_t y_{t+i} \right] \quad (2.22) \text{ and } y_t^T \text{ denotes transitory}$$

income defined as

$$y_t^T = y_t + \left( \frac{r}{1+r} \right) A_t - y_t^p \quad (2.38)$$

Assuming that there are no unanticipated capital gains, then the change in consumption is given by

$$\Delta c_t = \beta \Delta y_t + (1 - \beta) \left( \frac{r}{1+r} \right) \sum_{\tau=0}^{\infty} \left( \frac{1}{1+r} \right)^{\tau} (E_t - E_{t-1}) y_{t+\tau} \quad (2.39)$$

Thus, ‘even though transitory income and permanent income were defined as the transitory and permanent components of total income, inclusive of asset income, in the statement of the excess sensitivity hypothesis, the terms involving asset income cancel out, with the result that the first difference of consumption is a weighted average of the first difference of labour income and the expectation revision of the annuity value of future labour income’ [pp. 655]. In other words, the change in consumption due to an innovation in permanent income is less than one to one and can therefore be interpreted as liquidity constraints and/or precautionary savings. For example, if consumers receive good news today that their labour income will permanently increase tomorrow, they may decide to consume a proportion of their transitory income today until their higher labour income is realized if they cannot borrow to increase and therefore smooth their consumption. Moreover,

because consumers are reluctant to consume all of their transitory income and therefore all of their disposable income recognizing that they cannot borrow, perhaps this reluctance can be explained by precautionary savings.

In this model, savings are now scaled by  $(1 - \beta)$ , viz.

$$s_t = (1 - \beta) \left[ y_t - \left( \frac{r}{1+r} \right) \sum_{\tau=0}^{\infty} \left( \frac{1}{1+r} \right)^{\tau} E_t y_{t+\tau} \right] \quad (2.40)$$

This model is able to explain both excess sensitivity and smoothness. Sensitivity will occur if  $\beta \neq 0$ , and smoothness will occur if

$$\begin{aligned} \text{var}(\Delta c_t) &= \beta^2 \text{var}(\Delta y_t) + 2\beta(1 - \beta) \text{cov}(\Delta y_t, \Delta y_t^p) \\ &\quad + (1 - \beta)^2 \text{var}(\Delta y_t^p) < \text{var}(\Delta y_t^p) \end{aligned}$$

Using data for the US, Flavin found that the REPIH could be decisively rejected. However the restrictions which the excess sensitivity hypothesis imposes on the bivariate system of labour income innovations and savings<sup>32</sup> could not be rejected by the data.

### ***Buffer Stock/Precautionary Savings***

Carroll (1992;1997a) examines the role of precautionary savings in a REPIH framework where consumers facing important income uncertainty have a precautionary motive and are impatient. The model predicts similar results<sup>33</sup> to those suggested by Deaton (1991) as consumers engage in ‘buffer stock’ saving behaviour. Carroll demonstrates that consumers in this framework have a target wealth-to-permanent income ratio –  $w^*$  in Deaton’s work –

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<sup>32</sup> It is proposed by Campbell and Campbell & Deaton.

<sup>33</sup> Carroll’s model differs from that of Deaton in that it does not impose liquidity constraints and in that income is divided into its permanent and transitory parts. Consumers act as if they were liquidity constrained because whilst impatient, they show prudence. Carroll claims that Deaton’s results are due to his assumptions about impatient consumers and the convex marginal utility function rather than due to liquidity constraints per se. Carroll also claims that liquidity constraints reinforce the results of his paper.

such that if wealth is above target impatience will dominate prudence and consumers will dissave. The important result of Carroll's work is that he is able to put forward a formulation for the components of the optimal level of cash in hand  $w^*$ <sup>34</sup>.

Carroll shows that the Euler consumption equation is a problem similar to Deaton's if shocks to consumption are lognormally distributed:

$$E_t \Delta \ln c_{t+1} \approx \rho^{-1}(r - \delta) + \left(\frac{\rho}{2}\right) \text{var}_t(\Delta \ln c_{t+1}) + \varepsilon_{t+1} \quad (2.41)$$

where  $\rho$  is the coefficient of risk aversion,  $r$  is the interest rate,  $\delta$  is the rate of time preference. Consumption growth depends on three factors: the degree of impatience over precaution, a random effect, and the conditional variance of consumption in next period given information available in current period. The first two components are standard to intertemporal consumption behaviour. But the variance term, which is proven to play a significant role in consumers' behaviour, had not been investigated until Carroll's work. Carroll derives an expression for the average (aggregate) variance of consumption term to obtain further insights:

$$E_{.,t}[\text{var}_{i,t}(\Delta \ln c_{i,t+1})] \approx \left(\frac{2}{\rho}\right) \left[ g - \frac{\sigma_{\ln N}^2}{2} - \rho^{-1}(r - \delta) \right] \quad (2.42)$$

where  $g$  is the growth rate of permanent income and  $\sigma_{\ln N}^2$  denotes the variability of permanent income. From the Euler equation, Carroll (1992) demonstrates<sup>35</sup> that the expected variance of consumption growth is negatively related to wealth. Carroll (1997a) argued that this equation serves as

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<sup>34</sup> Deaton did not provide such explanation.

<sup>35</sup> Kimball (1990) has shown that for isoelastic utility functions, precautionary saving declines as wealth increases. Since precautionary saving adds to wealth over time, consumption will become less depressed. Hence, the reduction of precautionary saving when wealth increases generates the extra growth in consumption when  $E_t \text{var}(\Delta \ln c_{t+1})$  is high.

a means of providing inferences about the target level of wealth that consumers will hold to buffer themselves against an uncertain future, although it ‘should be viewed as a heuristic tool rather than as a rigorous analytical framework.’ [pp. 20].

The variance term in  $E_{i,t}[\text{var}_{i,t}(\Delta \ln c_{i,t+1})] \approx \left(\frac{2}{\rho}\right) \left[ g - \frac{\sigma_{\ln N}^2}{2} - \rho^{-1}(r - \delta) \right]$

(2.42) increases when the growth rate of permanent income,  $g$  and the rate of time preference,  $\delta$  increase. A higher than expected growth rate for permanent income will probably reduce the amount of income uncertainty for the individual and given their impatient nature, the consumer will consume more. When the consumer discounts the future less (i.e.,  $\delta$  falls) the individual is willing to postpone consumption and their stock of wealth

increases. The equation  $E_{i,t}[\text{var}_{i,t}(\Delta \ln c_{i,t+1})] \approx \left(\frac{2}{\rho}\right) \left[ g - \frac{\sigma_{\ln N}^2}{2} - \rho^{-1}(r - \delta) \right]$

(2.42) also shows that the variance term, which presents the target level of wealth, decreases (increases) when the rate of interest and the variability of permanent income increase ( $\sigma_{\ln N}^2$ ). The explanation of this result for both variables is straight-forward: as interest rates increase, the consumer becomes less impatient as consuming more in the present becomes more expensive and so the agent is willing to increase the amount of wealth that he or she holds. When the variability of the permanent income component increases, consumers become more prudent; and rather than behaving impatiently, begins to accumulate more wealth. Finally, the coefficient of relative risk aversion ( $\rho$ ) has offsetting effects: a higher coefficient represents a stronger precautionary motive (more wealth is accumulated due to the  $\rho/2$  term) but, at the same time, a higher  $\rho$  leads to a lower intertemporal elasticity of substitution, thus  $\rho^{-1}(r - \delta)$  decreases.

Carroll (1997b) has suggested that tests for the validity of the Euler equation

– as given by equation  $E_t \Delta \ln c_{t+1} \approx \rho^{-1}(r - \delta) + \left(\frac{\rho}{2}\right) \text{var}_t(\Delta \ln c_{t+1}) + \varepsilon_{t+1}$

(2.41) – using instrumental variables must be interpreted with caution because the variance term in that equation is likely to be endogenously determined by

$$\text{all of the variables in } E_{i,t}[\text{var}_{i,t}(\Delta \ln c_{i,t+1})] \approx \left(\frac{2}{\rho}\right) \left[ g - \frac{\sigma_{\ln N}^2}{2} - \rho^{-1}(r - \delta) \right]$$

(2.42). Thus, for instance, it would be incorrect to use interest rates as one of the instruments to test the Euler equation.

### *Aggregation with Finite Lives*

The existence of finitely lived life-cycle consumers may both explain the problems of excess sensitivity and smoothness that appear in the data. Clarida (1991) investigates the aggregate stochastic implications of Modigliani's life cycle hypothesis to explain the first and second moment properties of changes in per capita consumption. The main finding of the paper is that 'smooth per capita consumption in the presence of a permanent shock to per capita labour income is exactly the outcome one should expect from a properly aggregated life cycle model in which saving for retirement, as well for consumption smoothing, is a motive for asset accumulation' [pp. 853-4]. Since savings are required to finance consumption in retirement, agents will not react so strongly to permanent changes in their labour income as they need to save for retirement. This means that the MPC of a change in permanent income ought to be less than one (the REPIH assumes an MPC of one) and it is likely to decline monotonically with age. Clarida's main consumption equation is (in per capita terms)

$$\Delta c_t = \phi \lambda + \mu \varepsilon_t + \phi \eta_{t-1} \quad (2.43)$$

where

$$\mu = \sum \mu(j); \quad \mu(j) = \frac{1 + (1+r)^{-1} + \dots + (1+r)^{-(w-j)}}{1 + (1+r)^{-1} + \dots + (1+r)^{-(n-j)}} < 1$$

$$\phi \equiv \frac{n\mu}{w} \geq 1$$



and

$$\eta_{t-1} = \frac{1}{n} \sum_{i=w+1}^{n-1} \varepsilon_{t-n+i} + \frac{1}{n} \sum_{j=1}^{w-1} \varepsilon_{t-n+j} \left( 1 - \left( \frac{\mu j + 1}{\mu(1)} \right) \right)$$

where  $n$  is the number of periods the individual lives,  $w$  is the number of periods the individual works ( $n-w$  is the therefore the retirement period),  $j$  is the age of a consumer at time  $t$ ,  $\mu$  is the marginal propensity to consume out of labour income and  $\varepsilon_t (\equiv we_t/n)$  and  $\lambda (\equiv wg/n)$  are functions of the error and the drift term in the following specification for labour income,  $y_t = g + y_{t-1} + e_t$ . Clarida showed that, for plausible demographic assumptions, ‘the variance of changes in per capita consumption predicted by a properly aggregate life cycle model is substantially less than is implied by the representative agent permanent income hypothesis when shocks to per capita income are permanent’ [pp. 854]. The implications of  $\Delta c_t = \phi\lambda + \mu\varepsilon_t + \phi\eta_{t-1}$  (2.43) are followed:

1. Aggregate per capita consumption has a positive drift even though, by definition of the REPIH, individual consumption patterns are a random-walk without drift.
2. The drift in per capita consumption exceeds the drift in per capita labour income ( $\phi\lambda > 1$  since  $\phi > 1$  if  $r > 0$ ) whenever the rate of interest is greater than zero.
3. Changes in per capita consumption are correlated with lagged changes in labour income.

### ***Near Rationality***

Cochrane (1989) considers the conditions where agents follow alternative decision rules instead to those implied by rational expectations and explores the utility loss suffered by those agents. As a result Cochrane finds that the utility cost to an agent who decides to set their consumption equal to their current income rather than to their permanent income is less than ten cents to

a dollar per quarter. The utility costs are small because the utility costs of deviating from an optimum are an order of magnitude smaller than the deviation itself. An agent will not change their consumption unless a shock forces them to be relatively far away from their optimum, so that the costs associated with their changing consumption behaviour are exceeded by the utility gain from moving consumption to the optimum point.

### ***Partial Adjustment***

Attfield, Demery and Duck (1992) examine the possibility that consumers may be slower to adjust to changes to their permanent income than predicted by the permanent income hypothesis due to factors such as inertia or habit formation. Attfield *et al.* look at two models. The first one is a conventional, forward-looking quadratic cost of adjustment model and referred to as *PIH1*. The second specification, *PIH2*, examines the additional costs of planning required to enable the agent to reach the optimal level of consumption.

#### *PIH1*

Attfield *et al.* modify the permanent income problem developed by Flavin (1981) by assuming that consumers wish to minimize the following loss function

$$\text{Min } L = E_t \sum_{j=0}^{\infty} \rho^j [a_0 (c_{t+j}^* - c_{t+j})^2 + a_1 (c_{t+j} - c_{t+j-1})^2] \quad (2.44)$$

subject to the constraint

$$\sum_{j=0}^{\infty} \rho^j c_{t+j} = (1+r)A_t + \sum_{j=0}^{\infty} \rho^j y_{t+j}$$

where  $\rho = (1+r)^{-1}$ . In the paper,  $a_0 = \frac{1}{2}$  and  $a_1 = \frac{\alpha}{2}$ , where  $\alpha$  is a cost of adjustment parameter and  $c^*$  is the optimal level of consumption at each time period. The quadratic cost of adjustment makes large consumption

changes undesirable. After straight-forward manipulation, Attfield *et al.* obtain the following result

$$\Delta c_t = (1+r)(1-\theta)\Delta c_{t-1} + \theta w_t \quad (2.45)$$

where  $w_t = \sum_0^\infty \rho^i \Delta E_t \Delta y_{t+i}$  and  $\theta$  is a function of the two roots required to solve the first order condition of the problem. The change in consumption is no longer a martingale process but an  $AR(1)$  one. One must therefore include the lagged dependent variable and examine, under the null hypothesis, whether the error term is white noise. This is done by checking whether lagged variables have significant coefficients.

This model explains both excess smoothness and excess sensitivity. The change in consumption and hence in permanent income is likely to be correlated with lagged income because that change is written as a function of  $w_t$  which is itself correlated with lagged income. From  $\Delta c_t = (1+r)(1-\theta)\Delta c_{t-1} + \theta w_t$  (2.45)

$$\frac{\text{var}(\Delta c)}{\text{var}(w)} = \frac{\theta^2}{1 - (1+r)^2(1-\theta)^2}$$

and excess smoothness will arise if the ratio is less than one, i.e. if

$$1 - \frac{2}{[1 + (1+r)^2]} < \theta < 1.$$

## PIH2

According to the REPIH, forward-looking consumers need to ensure that not only is actual consumption at point  $t$  equal to desired consumption in point  $t$  but also that actual consumption in all future periods equals the expected level of desired consumption in all future periods. However, the costs of adjusting a variable may not be specific to the point in time that the adjustment takes place but may extend to other periods [Attfield *et al.* pp.

1206]. As a result the planning time required to making sure consumption is at its desired level may produce a slow adjustment of consumption to changes in permanent income.

Hence adjustment costs may arise under the REPIH problem. Given their tendency to discount the future, one would expect the effort devoted by individuals to planning their immediate future will exceed the amount of efforts they put into planning for the future. The proportion of permanent income which is unpredictable before current consumption decisions are made determine how much actual consumption will deviate from desired consumption: if a high proportion of permanent income is predictable well in advance, then actual consumption will be close to its desired level. Thus, in this model, it is assumed that there is 'some time span sufficiently long to ensure that any component of current permanent income which was predictable well in advance will have its full effect on current consumption' [pp. 1212]. This is shown in the following equation:

$$c_t = E_{t-n}y_t^p + \sum_0^{n-1} \gamma_i \Delta E_{t-j}y_t^p \quad (2.46)$$

where  $n$  defines the time span over which the adjustment is less than complete and where the  $\gamma$ 's follows the pattern  $0 \leq \gamma_0 \leq \gamma_1 \leq \dots \leq \gamma_{n-1} < 1$ . Since the change in expectations is unpredictable,  $E_t y_t^p - E_{t-1} y_t^p = e_t$  then becomes  $E_{t-1} y_t^p - E_{t-2} y_t^p = \zeta_0 e_{t-1}$ , where  $\zeta_i = [1 + r(1 - \gamma_i)]$ . It is presented as followed:

$$\Delta c_t = \sum_0^n \phi_i e_{t-i} \quad (2.47)$$

where  $\phi_0 = 1 - \beta_0$ ,  $\phi_j = [\beta_{j-1}/(\rho - \beta_j)]$  for  $0 < j < n$ ;  $\phi_n = \beta_{n-1}/\rho$  and  $\beta_i = [(1 - \gamma_i)\zeta_{i-1}\beta_{i-1}]/(1 - \gamma_{i-1})$  for  $i > 0$  and  $\beta_0 = 1 - \gamma_0$ . Thus the change in consumption is an  $MA(n)$  process, where the error term is a function of

changes in the expectations about permanent income. This equation can explain both excess sensitivity and excess smoothness. Hence  $e_t$  is white noise by definition, we can write:

$$\text{var}(\Delta c_t) = \text{var}(e_t) \sum_0^n \phi_i^2 \quad (2.48)$$

Excess smoothness will arise if  $\sum_0^n \phi_i^2 < 1$ .

Excess sensitivity arises in this problem because lagged shocks to permanent income, which are likely to be correlated to lagged innovations in labour income, are shown to influence the current change in consumption.

Attfield *et al.* find that US and UK data favour both the *PIH1* and *PIH2* models over the random-walk specification of Hall. They argue that the *PIH2* specification is the preferred one as US data was not able to formally reject that specification. For UK data, such a rejection was less decisive.

### ***Information-Aggregation***

Goodfriend (1992) shows that the orthogonality restrictions implied by intertemporal optimization, rational expectations and information processing need not hold under the aggregation of randomly heterogeneous and imperfectly informed representative agents. Economic variables are generated by aggregate and relative components which agents must distinguish between to follow optimal decision rules. Agents may be imperfectly informed because data they use are published with at least one period lag and because of the need to distinguish which part of their current income change is an aggregate one and which one is a relative one. Then the relative persistence of each component is held to explain the failure of the REPIH. These issues are investigated in more detail by Pischke (1995) who extended Goodfriend's model by assuming that aggregate information may play a small role in household decisions since 'ignoring it is not very costly for most households'

[pp. 807]<sup>36</sup>. The optimal reaction of agents to changes in their individual and aggregate incomes is investigated to assess their subsequent consumption decisions. In each of Pischke's models, it is assumed that agents have individual specific income processes that are different from the time series structure of aggregate income. However, it is assumed that all the other assumptions of the REPIH hold.

All the models Pischke considers, agents have identical income processes, but each faces a different realization of this process in every time period. The simple income process assumes  $\Delta y_{it} = \varepsilon_t + (1 - L)u_{it}$ , where subscripts  $i$  denote individual variables while no subscripts refer to aggregate variables. Both errors are uncorrelated by the assumption<sup>37</sup>. In particular, Pischke examines three scenarios:

- 1) Complete Aggregate Information. In this case the micro agent has full contemporaneous information on aggregate income so that individual and aggregate income changes can be distinguished. This corresponds to the permanent income models of Hall and Flavin.
- 2) Unobservable Aggregate Shocks. The individual cannot distinguish between aggregate and individual income components. A simple income process for the micro agent is assumed to look like this

$$\Delta y_{it} = \eta_{it} - \theta \eta_{it-1}$$

where  $\theta$  is a function of the individual and aggregate components  $\varepsilon$  and  $u$ . With this income process, Pischke shows that the per capita consumption innovation will be

$$\Delta c_t = \theta \Delta c_{t-1} + A \varepsilon_t$$

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<sup>36</sup> This assumption can be based on near-rational considerations.

<sup>37</sup> Other income specifications where the aggregate errors are white noise and the individual errors are random-walks can be considered (as well as other modifications).

where  $A = (1 - [\theta/(1+r)])$ . Consumption does not follow a random-walk but an  $AR(1)$  process. Excess sensitivity and smoothness are both present in this model: if the researcher runs an excess sensitivity test of the type  $\Delta c_t = \alpha + \beta \Delta y_{t-1} + e_t$ , then the estimated sensitivity coefficient, which should be zero, is

$$\hat{\beta} = \frac{\text{cov}(\Delta c_t, \Delta y_{t-1})}{\text{var}(\Delta y_{t-1})} = \frac{E\{A(\frac{\varepsilon_t}{1-\theta L})\varepsilon_{t-1}\}}{\sigma_\varepsilon^2} = A\theta$$

and the degree of excess sensitivity depends on the parameter  $\theta$ . Excess smoothness arises because

$$\frac{\sigma_{\Delta c}}{\sigma_\varepsilon} = \frac{A}{\sqrt{1-\theta^2}} < 1$$

if the rate of interest is small enough and  $\theta > 0$ . Hall's representative model would hold if the aggregate and the individual income processes have the same persistence properties.

- 3) Lagged Information about Aggregate Shocks<sup>38</sup>. In this case, the individual  $i$  can only observe both  $y_{it}$  and the aggregate shock  $\varepsilon_{t-1}$  at time  $t$ . The consumer also has knowledge of the history of both variables so that they are able to infer  $u_{it-1}$ . The income process for the individual now takes the form

$$\Delta y_{it} = v_{it} - u_{it-1}$$

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<sup>38</sup> This is Goodfriend's model.

where  $w = \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + \sigma_u^2}$  is a kind of signal extraction parameter.

Aggregate consumption does not follow a random-walk but an  $MA(1)$  process. According to Pischke, the response to an aggregate shock is larger in the no information model than in the lagged information model since  $(w+r)/(1+r) < A = [1 - (\theta/(1+r))]$ . The lagged information model contains information on contemporaneous shocks, whilst the no information model also contains new information on lagged shocks so that the agent's response to innovations in income differs in both models.

The lagged information model will exhibit both excess sensitivity and smoothness. The excess sensitivity coefficient is given by

$$\hat{\beta} = \frac{E\left\{\left[\frac{w+r}{1+r}\varepsilon_t + (1-w)\varepsilon_{t-1}\right]\varepsilon_{t-1}\right\}}{\sigma_\varepsilon^2} = 1 - w \quad (2.49)$$

which is different from zero. Excess smoothness arises because

$$\frac{\sigma_{\Delta c}}{\sigma_\varepsilon} = \sqrt{\left(\frac{w+r}{1+r}\right)^2 + (1-w)^2}$$

which Pischke demonstrates is less than one for small value of  $r$ .

Pischke then looked at the predictions made by models using empirical estimates for the individual and aggregate parts of the income process. Pischke assumed that the individual income and aggregate income processes are described by an  $MA(2)$  specification in first differences. By definition the consumption processes differ from the case of the no information<sup>39</sup> and the

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<sup>39</sup> Consumption follows an  $ARIMA(M, \text{Fridman } 1957)$ .



lagged information models<sup>40</sup>. Pischke then obtained estimates for  $\beta$  and the variance ratio for different values for the coefficients in the  $MA(2)$  income process and for different measures of the variability of the two components of the income process. He found that both the no information model and the lagged information model predict parameters which were very close to the time series properties of aggregate consumption but was unable to say which of the two models better explained the data, although both performed better than the full information model.

In two more recent studies, Demery and Duck (1999;2000) have identified the appropriate restrictions that the models of Goodfriend and Pischke imply for the dynamics of aggregate consumption. Using US and UK time series data, Demery and Duck found that both models can be formally rejected by the data, although Pischke's model explains some features of the data better than the permanent income hypothesis.

### ***Other explanations***

Christiano, Eichenbaum and Marshall (1991) investigated the time horizon in which consumption decisions are made. They specifically address the criticism that consumers have no grounds for planning their actions in an annual, quarterly or monthly basis and instead argue that agents make such decisions on a continuous time basis. The assumption that agent's decision intervals match the data-sampling interval is thereby replaced by the assumption that agents make decisions at time intervals which are even finer than this. Their work is based on the previous finding that temporal aggregation bias can induce serial correlation and spurious Granger-causality correlations. Christiano *et al.* find that their continuous time variant of Hall and Flavin's models satisfies the martingale hypothesis and argue that their empirical findings, which suggest that the first difference in consumption is serially correlated and Granger-caused by a variety of other variables, are explained entirely by a temporal aggregation bias.

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<sup>40</sup> Consumption changes are an  $MA(1)$ .

Bernanke (1985) suggests that durable goods and adjustment costs could explain the excess sensitivity. Bernanke studies the consumer's optimal spending patterns on durable and non-durables that are jointly determined.

Muellerbauer (1988) examines whether lagged dependent variables in consumption represent agents' expectations or adjustment costs, habits or the durability of goods. Muellerbauer argues that habits, like convex adjustment costs, can account for the excess smoothness finding although he rejects these arguments as the complete explanation for the failure of the REPIH specification. Muellerbauer (1994) suggests that other types of adjustment costs may in fact account for the failures of the REPIH.

Heaton (1993) examines habit formation and time-aggregation issues. He found that monthly consumption changes were negatively correlated, not positively correlated as were the quarterly changes. He suggested a model where the utility function would depend positively on stocks that come from the accumulation of purchases, and negatively on habits. In that model durability would dominate over short periods but where habits become more important as the observation period increases.

## 2.3 CONCLUSION

This chapter has reviewed the most important developments in the consumption literature. Since the late 1970s, it appeared that consumption behaviour could not be modelled empirically. This led Muellbauer and Lattimore (1995) to summarize the then state of consumption research as ‘far from satisfactory’ [pp. 222]. In particular, the endogeneity of income in the consumption regression has been a major obstacle in empirical evaluations of the model. Moreover the technique, in which lagged values of income act as predictors of current and future income inevitably takes the form of a distributed lag model in the empirical estimation, has faced numerous criticisms. In 1978, Hall’s consumption function was published called as an important breakthrough in testing the implications of the benchmark model. Following the rational expectations revolution – most forcefully advocated by Lucas in his famous critique – Hall introduces rational expectations and a number of other assumptions into the permanent income model of Friedman. He attempts to capture the stochastic implications of theory in a rational expectations setup. Hall’s consumption function argued that consumption should roughly follow a random-walk pattern apart from a trend, with lagged values of income having no role to play in predicting present consumption. This is because information is unpredictable by its very nature and cannot be systematically predicted. Therefore it should not be possible to predict consumption. Hall tested this claim and found empirical to support for his hypothesis<sup>41</sup>. However, subsequent tests over more than two decades found that Hall’s consumption function could be formally rejected using data from a number of different countries as consumption changed appeared to react too strongly to current income<sup>42</sup> and too weakly to permanent income<sup>43</sup>. This suggests it should be possible to identify some variables that should prove useful for predicting changes in consumption.

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<sup>41</sup> Strictly speaking, Hall only attempts to test the hypothesis that consumers try to smooth marginal utility. Because his marginal utility function is linear, this implies that he is testing whether consumers smooth their consumption or not.

<sup>42</sup> It is called the excess sensitivity.

<sup>43</sup> It is called the excess smoothness.

Consequently, this chapter presented some of the empirical studies that have tested the truth of both the REH and the REPIH, and described the principal theories which claim to explain why Hall's consumption function fails at the aggregate level. Two main conclusions can be drawn: First, the bulk of empirical research on aggregate consumption has been undertaken on two data sets for the US and the UK economies that end in the mid 1980s. In other words these tests are out of date and based on a limited amount of data. Second, while there have been many different explanations given for the failure of the random-walk hypothesis, most involve different economic theories/concepts which in turn lead to very different consumption specifications. As a result there is therefore no common consensus about what the underlying consumption function should look like.

In the last decade, there has been much effort focusing on the question of whether the response of consumption to income changed is consistent with the permanent income hypothesis using micro panels<sup>44</sup> and macro time series data sets. Many researches based on these, like that of Campbell and Mankiw (1989;1990) and Shea (1995ab), indicate a failure of the REPIH. However, Attanasio and Weber (1995) show that the pattern of US non-durable expenditure observed in household-level data conforms to the predictions of the standard theory on consumer intertemporal optimization. Amidst the contradictory results contrived from the various studies in this area, it becomes increasingly hard to explain the empirical puzzles that have surprised theoreticians for over five decades. As a result of the contradictory results gathered from the various studies in this area, there is a need for extensive evaluation of the theory. This study seems to derive a benchmark case study for the United Kingdom economy to help analyze these empirical puzzles.

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<sup>44</sup> Zeldes (1989) confirms the presence of excess sensitivity of low-wealth households and emphasizes the importance of liquidity constraint in explaining the apparent excess sensitivity based on a micro data.

## *Chapter 3*

# **DATA DESCRIPTION AND EXPLORATION**

### **3.1 INTRODUCTION**

In traditional ‘time-series’ applied micro-econometrics, economists use data on aggregate quantities collected over time to model economic relationships. But it is unclear whether on how this method relates to the behaviour of individual agents. As a result, more and more economists are now focusing on developing alternative frameworks within which they can use data collected from individual agents to model the behaviour of such agents.

There are many reasons that micro-data sets are used in applied micro-econometrics: from econometric theorists who are interested in testing a theory at work to policy-makers interested in knowing the potential impact of a proposed policy change. But, most probably, it is true to say that there is more of an active interest in the concept subjectivity today than there has ever been in the past. There are several related reasons for this. The first one is the increased availability of micro-data. More surveys are operated today than ever before and more survey data are made available for general use. Secondly the rapid progress of computer technology over recent years has made it easier to store and process the increasing amounts of such data. Thirdly, and most importantly, the power of computers today makes possible what was considered impossible twenty years ago, in terms of estimating of the necessarily complex statistical models which use the increasing amount of available micro data.

The internal complexity of micro-econometric models arises largely from certain clumsy features possessed by micro data. Pudney (1989) discussed these issues. The behaviour of individual agents is often characterized by non-linearities, kink and discontinuities. Conversely, at the aggregate level, as variables are effectively averages over the population, these ‘clumsy features’ are not present because they have been, completely or at least partly,

eliminated by the process of aggregation. Thus, in the case of aggregation, simple statistical models, such as least squares estimation, are therefore much more likely to suffice.

As a result there is an incentive to move from the individual level to the aggregate level in applied micro-econometrics as this can eliminate the problems associated with micro data and validate the more straightforward statistical techniques associated with aggregate data. However there is a drawback with this. Firstly, any aggregation data must involve information loss while individual micro data can allow an economic problem to be viewed in its richest possible form. Thus models involving aggregates are impossible for explaining individual behaviour while strong assumptions are often required concerning the cross-section distribution of the model's variables. Fry and Pashardes (1989) run an empirical investigation into the problems associated with moving from the household to the aggregate level in the analysis of tobacco consumption. They find that such problems are severe, and ascribe these to the complicated nature of the household decision making process which determines smoking behaviour. For these reasons, I am concerned more on movement towards individual data in this thesis.

The dataset used as a vehicle for this is the British Household Panel Survey (2003). The British Household Panel Survey started with a baseline survey in 1991 and has provided data for many of units of observation in a cross-section sample which are surveyed annually. It satisfies the basic requirements of being data on individual units as opposed to aggregates, and in being heavily disaggregated in terms of the quality data it covers. In fact, it would be hard to find a dataset which is more suitable for understanding the dynamics of change of the whole population in the UK in which I am most interested. Generally, more than one variable of interest are involved in micro-econometric models. The variable of interest is that variable the parameters of whose conditional distribution I wish to estimate. The variable of interest is likely to have emerged from an economic model of individual behaviour, in

which case the parameters of its conditional distribution are the parameters of the underlying economic model.

It is common that the variable of interest is detached from the observed variable in some way in the process of estimating a micro-econometric model using micro data. In general, the observed variable cannot show up all the information on agents and this information is not usually restricted for some reasons. This detachment may take four forms in the observed variables, censoring, grouping, truncation or some combination of these. As a result, the most fundamental problem in applied micro-econometrics is what empirical economists are striving toward model is often different from what is observed in the real world.

Amemiya (1973) mentions the crucial importance of this ‘damaged’ data issue which was referred to in the last paragraph. It is suggested that the stochastic specification of a model must be correct to eliminate this problem and ensure consistency of the maximum likelihood estimates (MLE). This is in contrast to the general linear model, in which the MLE is consistent whatever the nature of the model’s stochastic element. With damaged data, the estimates obtained from any such model should not be taken seriously without rigorous testing of the model’s distributional assumptions.

I have acquainted the concept of the term variable of interest that may arise from an economic model or some other type of behavioural model. In this thesis the traditional models of consumption are discussed in terms of variable of interest.

Traditional models of consumption are considered for application to time series data on aggregate quantities. Such models are usually constructed with the individual agent in mind within the framework of a constrained utility maximization problem. One example is Stone (1954) who derives the Linear Expenditure System from a simple direct utility function, and relates each goods consumption linearly to its price and the consumers’ income. Another is Deaton and Muellbauer (1980a) who derive the Almost Ideal Demand

System (AIDS) from a flexible expenditure function while relate the budget share of each good to the logs of prices and the log of real income. There are also many other examples. For example, Christensen *et al.* (1975) and Theil (1965) present some of the most widely used models. These models are all comparatively straightforward to estimate, many are linear in parameters and have been considered useful in the modelling of aggregate time-series expenditure data, although the results in terms of the testing of the underlying economic theory have generally been not satisfied. Because of these rejections of theory, some authors, like Christensen and his colleagues, began to explore alternative explanations beyond the framework of constrained utility maximization. Likewise, Deaton and Muellbauer (1980b) argue that such models are also inadequate for capturing the true nature of consumer behaviour.

The increased availability of panel survey data over recent years and the increasing empirical work in which such data are applied have naturally led to the increased use of such data to model consumption. From aggregate expenditure data to cross-section expenditure data, there are four important changes occurring and each leads to a completely new type of econometric model. Firstly, it is assumed that there is no price variation in cross-section data. All households in a single cross-section are assumed to face the same price. All prices involved in the model are included in the constant term of the equation, and, under this assumption, an equation relating expenditure on a good to household income can be obtained. Since there is no price variation, the testable implications of consumption theory, namely homogeneity, symmetry and negativity, are no longer testable hypotheses.

The second change is that characteristics of households can be included in the models as conditioning variables. The most useful of these are demographic variables like gender, education level, household size and so on. For example, Chesher and Rees (1987) modify the AIDS system of Deaton and Muellbauer (1980b) to incorporate demographic variables in a way that preserves the



linearity of the model. Pollak and Wales (1981) discuss alternative methods for incorporating demographics.

The third important difference is that, a distinction needs to be made between consumption and expenditure when we use cross-section data. Consumption is usually thought of as a continuous process while expenditure is seen as an event that occurs at discrete period intervals. In other words, the quantity purchased over a one-week period is likely to be either greater or smaller than the quantity consumed over the same period. But in most cases of empirical research, expenditure acts as the observed variable when consumption is our interest variable. The rift between these two variables is one manifestation of the fundamental problem in micro-econometrics: what is modelled does not correspond exactly to what is observed. However, if we used aggregate data, the problem would be eliminated: if we took an average of weekly expenditure in a certain time period over the population, household spending less than they would compensate for those purchasing more than they consume with the result that average expenditure would equal average consumption.

The fourth important change when we move from aggregate to cross section data is that of zero observations in the data. When we consider the households consume a particular item, it is reasonable to expect that some of them are not consumers of this item. The possible reasons for this are that their income is too low, or some other characteristic which they have. These households are considered to be at corner solutions. In this case, a zero expenditure will be recorded even if the period of time is sufficiently long. Because of this feature of the data, the linear econometric methods applied to aggregate data are simply not suitable, because such methods are based on continuous distributions and do not allow a positive probability for a zero observation. As a result, when linear methods are used, the estimates obtained are generally inconsistent. The extent of this problem depends on the nature of the zero observations in the sample. Not all the zero observations are necessarily corner solutions. Some may result from the nature of the

purchasing process. In other words, it might be that an expenditure is not observed in the survey period even when a household does consume the good. This type of zero observation is referred as an 'infrequency zero'. If all zero observations are infrequency zeros, all households are consumers of the good, but not all are observed purchasing it at any point in time, then it is appropriate to apply linear econometric methods. The observed expenditure data can simply be considered as consumption measured with error, and in such circumstances linear methods consistently estimate the conditional mean of consumption. However, at the micro level, it is unreasonable to assume that any good is consumed by all households. It is therefore likely that the zero observations in any sample are a mixture of corner solutions and infrequency zeros.

Moreover, there are other possible explanations for zero observations. If a household would never purchase the good under any circumstances, we refer to this case as 'abstention'. One of examples is meat consumption in a vegetarian household. Abstention, in this case, can be thought of as an extreme case of a corner solution. Another possibility is non-disclosure. Households may wish to conceal information from the interviewer, resulting in zero expenditure being incorrectly recorded. Deaton and Irish (1984) have considered the statistical problems associated with non-disclosure in terms of expenditure on tobacco and alcohol. But the problem is not relevant in this study since food expenditure, which is used as a measure non-durable consumption in this thesis, is not a sensitive issue. Hence it seems unnecessary to assume a household has much incentive to withhold the truth about their consumption pattern in a food expenditure survey.

Meanwhile considering these problems in the transition from the macro-level data to the micro-level data, my analysis of consumption would be concerned on the cross-section time series data like panel data in the micro level in this thesis. The following section discusses the details of panel data.

### 3.2 PANEL DATA ANALYSIS

In general, there are three types of database analysis: cross-sectional, longitudinal, and panel. Cross-sectional analysis focuses on respondents at one point in time and gives a representative picture of current social conditions at this point. Longitudinal analysis highlights the same people repeatedly through a period and compares their successive states. Panel analysis helps us to track individuals' position through historical time. Panel analysis can be categorized into retrospective and prospective studies. Respondents are required to reconstruct some views and periods of their life in the retrospective study. Prospective study involves collecting information more or less simultaneously with the actual events portrayed. Recently, more and more economists have been interested in the understanding of process of macro-social changes and changes at the micro level that are experienced by individuals, families and households. As a result, panel research is playing a much more important role in scientific activity and becomes an increasingly popular form of longitudinal data analysis among social and behavioural science researchers. In this section I discuss the origins of panel data, show the development of it, consider a small sample of panel data, and present an appraisal of its utility.

#### 3.2.1 Definition

A panel is a number of households or individuals who are surveyed and followed periodically over a given time span. The term panel data refers to “the pooling of observations on a cross-section of households, countries, firms, etc. over several time periods.” (Badi H. Baltagi 2001 p.1) Panel data is “data which consists of both time series and cross-section values, e.g. a data set that consists of spending by a large sample of households for several years.” (Graham Bannock *et al.* 1998 p.311), Panel data is often concerned with issues such employment, travel to work and mobility, earnings and incomes, durable consumption like housing, and non-durable consumption like food and grocery, and used to monitor and explain changes in economic wellbeing and to study the effects of economic and social programs. As an

example, Balestra and Nerlove (1966)’s analysis is based on the data on 36 US states over 13-year period. Panel data is also distinct from both pure cross-sectional data and pure time-series data. Observations on agents in pure cross-sectional data are at a point in time while observations in pure time-series data usually have an aggregate nature and without any longitudinal dimension. For some purpose, it may be useful to view cross-sectional data as a panel without a time dimension. In other words, panel data can be considered as “cross-sections over time” or “pooled” cross-sectional time-series data if we ignore the question of whether the cross-sections over time refer to identical agents or not<sup>45</sup>. In social science, researchers apply panel data to conduct longitudinal analyses in wide range of fields. For example, it is used to study classes of students or graduates over time in education; the behaviour of political parties and organizations over time in political science; the characteristics of groups of people followed over time are explored in sociology, psychology, and health research; while in economics panel data analysis has enabled researchers to analyze the behaviour of firms and individuals over time.

### *3.2.2 Development*

US panels started operating in the 1960s. The two most well-known examples are the Panel Study of Income Dynamics (PSID) collected by the Institute for Social Research at the University of Michigan and the National Longitudinal Surveys of Labour Market Experience (NLS) collected by the Centre for Human Resource Research at Ohio State University and the Census Bureau. A large number of studies have used the PSID and NLS data sets. The Longitudinal Retirement History Study is another important labour force panel, which followed individuals aged 58-63 in 1969. The Current Population Survey (CPS) is constructed by the Census Bureau centres on labour force statistics and contains fewer variables with shorter time spans compared with the NLS and PSID. The University of Michigan also collects the Health and

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<sup>45</sup> Verbeek (1996) gives a useful survey of methods used to treat repeated cross-sections, not necessarily involving the same agents.

Retirement Study (HRS) from 1992. More than 21,000 people over the age of 50 are surveyed.

The European panels started being set up in the 1980s. The German Institute for Economic Research began to collect the first wave of the German Socio-Economic Panel (GSOEP) in 1984, which covers all persons above the age of 16 in the households sampled. Standard demographic variables as well as political involvement, wages and income, benefit payments, level of satisfaction with various aspects of life, hopes and fears, etc are collected. Statistics Netherlands has operated the Dutch Socio-Economic Panel (ISEP) from 1984-1997. The Luxembourg Panel Socio-Economique (PSELL) is based on 6110 individuals over the period 1985-94. The French Household Panel (1985-90) includes 2092 households. The Belgian Socioeconomic Panel covers a representative sample of 6471 Belgian households in 1985, 3800 in 1988 and 3800 in 1992. The Russian Longitudinal Monitoring Survey (RLMS) has been collected since 1992 by the Carolina Population Centre at the University of North Carolina. Statistics Canada started collecting the Canadian Survey of Labor Income Dynamics (SLID) in 1993. The Hungarian Household Panel (1992-96) with a reference population of 2059 households is collected by the Social Research Information Centre. The Institute for Household Economy constructed the Japanese Panel Survey on Consumers (JPSC) in 1994. The Swiss Household Panel (SHP) involved 7799 individuals first interviewed in 1999. The British Household Panel Survey (Elena Bardasi *et al.* 2003) is an annual survey of private household in Britain. The Institute for Social and Economic Research at the University of Essex first collected it in 1991. The BHPS is a national representative sample of more than 5000 households containing demographic and household characteristics, household organization, labour market, health, education, housing, consumption, income, social and political values. More details of the BHPS are presented in section 3.3.

In 1994, the Statistical Office of the European Communities (EuroStat) commenced the design and coordination of the European Community

Household Panel (ECHP), which was linked to existing national panels from the beginning or ran parallel to existing panels with similar content. In 1997, the ECHP was merged into the GSOEP, PSELL and BHPS.

### *3.2.3 Advantages and Limitations*

Panel data offers several important advantages over data sets with only a longitudinal or a temporal dimension. These include the following:

- 1) Their use may offer a solution to the problem of bias caused by unobserved heterogeneity<sup>46</sup>, which is a common problem in fitting economic models to cross-section data sets. Neither time-series nor cross-section studies control for this heterogeneity. For example, Hajivassiliou (1987) analyzes the external debt repayments problem using a panel of 79 developing countries over the period 1970-82. He investigates country-specific variables, such as colonial history, financial institutions, religious affiliations and political regimes and finds that these variables affect the lenders' attitudes to these countries with regards to borrowing and defaulting and the way they are treated. The omission of this country heterogeneity would lead to serious misspecification. Panel data are able to control for these country-variables whereas a time-series study or a cross-section study cannot.
- 2) A second attraction of panel data is that they usually have very large numbers of observations compared to other types of datasets. As a result, there is more information, more variability and less collinearity among the variables in panel data compared to others. Thus more degrees of freedom and efficiency are generally available in panel data sets than with conventional time-series data, although cross-section data sets are often very large. For example, in this paper, because there are 28243 observations

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<sup>46</sup> E.g. see Moulton (1986;1987)

in 12 waves of the BHPS, there are potentially  $28243 \times 12 = 338916$  observations. Further, because it is expensive to establish and maintain them, panel data sets tend to be well-designed and rich in content at the beginning of operation.

- 3) Panel data are better able to reveal dynamics that are difficult to detect with cross-section data. Cross-sectional distributions appear relatively stable and fail to reveal a great number of information on changes. Moreover, because panel data are less highly aggregated than typical time-series data and the same individual units can be observed through time, researchers can test more complicated dynamic and behavioural hypotheses than those that can be tested using uni-dimensional data. As a result, panel data are considered to be a suitable vehicle to study processes such as unemployment, job turnover, residential and income mobility, and the duration of economic states. For example, in measuring unemployment, cross-sectional data can estimate what proportion of the population is unemployed at a point in time and will find that some individuals are employed, some are unemployed, and the rest are economically inactive. However for policy purposes, one would like to distinguish between frictional unemployment and long-term unemployment. As the later can indicate a serious social problem. Thus policy makers designing an effective policy to counter long-term unemployment need to know the characteristics of those affected or at risk. In principal it is possible to capture the information with a cross-section survey using retrospective questions about past labor force status. However, in practice the scope for this is often very limited. The further back into the past we go, the worse are the problems of a lack of records and fallible memories, and the greater becomes the problem of measurement error. Panel data avoids this problem and can estimate what proportion of those who are unemployed in one period remain

unemployed in another. Also, “panels are necessary for the estimation of intertemporal relations, life-cycle and intergenerational models.” (Badi H.Baltagi ,p.7)

- 4) More complicated behavioural models than those using purely cross-section or time-series data can be constructed and tested with the help of panel data. For example Baltagi and Griffin (1988) and Cornwell, Schmidt and Sickles (1990) argue that technical efficiency is better studied and modelled with panels.
- 5) Panel data usually consists of micro units, like individuals, firms and households. Because many variables can be more accurately measured at the micro level, any biases resulting from aggregation are eliminated<sup>47</sup>.

However, on the other side of the coin, Badi (2001) argues that there are four main limitations of panel data. These are as followed:

- 1) Design and data collection problems. Kasprzyk *et al.* (1989) discuss the problems that arise in designing panel surveys as well as data collection and management issues. These are problems of coverage<sup>48</sup>, non-response<sup>49</sup>, recall<sup>50</sup>, frequency of interviewing, interview spacing, reference period, the use of bounding and time-in-sample bias.
- 2) Distortion of measurement errors. Faulty responses due to unclear questions, deliberate distortion of response, memory errors, misrecording, inappropriate informant and interviewer effects in the process of collecting panel data may cause measurement errors.
- 3) Selectivity Problems.
  - i. Self-selectivity. In cases where the reservation wage is

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<sup>47</sup> see (R. Blundell 1988;1996); (N. A. Klevmarken 1989)

<sup>48</sup> Incomplete account of the population of interest

<sup>49</sup> Due to lack of cooperation of the respondent or because of interviewer error

<sup>50</sup> Respondent not remembering correctly



higher than the offered wage, people can choose not to work. So, in such circumstance, we observe the characteristics of these individuals instead of their wage. The sample is expurgated if only their wage is missing. But this would be a truncated sample if we do not observe all data on these people. Inference from a truncated sample introduces bias that is not helped by more data because of the truncation<sup>51</sup>.

- ii. Non-response. Item non-response occurs when one or more questions are left unanswered or are found not to provide a useful response. Non-response can make serious identification problems for the population parameters. Horowitz and Manski (1998) argue that the seriousness of the problem is directly proportional to the amount of non-response. Non-response rate in the first wave of the British Household Panel Survey is 26%. The comparable non-response rate for the first wave of the PSID is 24%, for the GSOEP (38%) and for PSELL (35%).
- iii. Attrition. If subsequent waves of the panel are subject to non-response, we call this more serious problem 'attrition'. The degree of attrition varies depending on the panels. The attrition rate varying from the first and second wave is 12% in the BHPS. Rotating panels, where a fixed percentage of the respondents are replaced in every wave to replenish the sample, are sometimes used in to counter the effects of attrition.
- 4) Short time-series dimension. The number of individuals tending to infinity in panels crucially affects asymptotic arguments in analysis. Increasing the time span of the panel increases cost and the chance of attrition.

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<sup>51</sup> see (J. A. Hausman, D. Wise 1979)

In sum, the increasing availability of panel data provides rich and powerful data sets for researchers who are interested in studying both the space and time dimensions of economy and social phenomenon. These data sets are called *balanced* panel data if there is an observation for every unit of observation for every time period. But if there are missing values, a panel is described as *unbalanced*. The analysis in this thesis applies to unbalanced panel data, because missing observations are endogenous to the model while a balanced panel, which could be created artificially by eliminating all units of observation with missing observations, may lack the representative nature of the underlying population.

### 3.3 BHPS DATA DESCRIPTION

#### *3.3.1 Introduction*

There are four major national household panels: the Panel Study of Income Dynamics (PSID) surveying a large representative sample of the US population; the German Socio-economic Panel (SOEP) which gathers data on issues ranging from labour market and income issues to the value of domestic production; the British Household Panel Survey, which is a random representative survey at the micro-social level of around 5,500 households and over 10,000 representative British people; and the Hungarian SOEP, which uses a similar sample and set of rules to the BHPS to describe the rapid changes occurring in Hungarian society.

This study intends to focus on the BHPS. The BHPS has been collected and analyzed by the ESRC Research Centre for Micro-social Changes at the University of Essex over a period of years and monitors and describes the responses of individuals, families and households to macro change. The BHPS also combines components of both prospective and retrospective studies as it not only uses similar variables and questions to those used in cross-sectional surveys to trace their changes, but also allows the construction of continuous variables to analyze individuals' behaviour over time. There are six broad topic areas included in the questionnaire: household organization, the labour market, housing, income and wealth, health, and socio-economic values.

The data used in the analysis are taken from the BHPS from September 1991 through to September 2002. The bulk of interviews are taken place by the end of December each year, although some of them do extend well into the following year. The end of the following April is the cut-off point. The BHPS is a random sample from the British population. One of the most attractive characteristics of the BHPS is that we can use it to examine the relationships

between respondent's financial expectation<sup>52</sup> and their actual consumption outcomes. Likewise, to understand the broader impact of uncertainty on individual welfare situation, we can also investigate the interaction between the households' observed behaviour (for example, their savings and purchases of consumer durables) and their feelings of financial wellbeing<sup>53</sup> or, in order to explore the rationality of consumers expectations, the BHPS provides us with panel data with which we can compare a sample member's expectations in one wave with out-turns in a subsequent wave. Unfortunately, the household's responses to questions only involve their financial situation instead of the exact amount of expected income. For example, respondents answer the question like "Looking ahead (back), how do you think yourself will be financially a year from now (ago), will it be better than now, worse than now, or about the same?" The answers to all such questions are discrete and ordered. But it still can help us to identify the characteristics of respondents' expectations and the ability of their introspection in the successive waves using ordered discrete variables. Furthermore, using the BHPS allows us to explore how individuals form their expectations in comparison with early investigation that relied on aggregate data.

### *3.3.2 Purpose*

The BHPS is a household survey based on a sample of the whole population of Great Britain and its intention is to understand the dynamics of change of the whole population, and its evolution over the lifetime of the study. Each individual wave of the BHPS addresses issues of relevance to the whole age range. It also collects data and usually follows all the people living in the sample household instead of just a reference individual.

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<sup>52</sup> In questionnaires, observers are required to predict their future financial statement, better off or worse off, instead of the expected income. "Looking ahead, how do you think you yourself will be financially a year from now, will you be better off than you are now, worse off than you are now, or about the same?"

<sup>53</sup> A narrow interpretation is current income; a broader interpretation would also take into account the values of any assets they hold and the incomes they expect to receive in the future. Most interesting, some who had experienced an increase in current income felt themselves worse off.

The first and central purpose of the BHPS is to provide high quality data on the short-term processes of change at the individual and household level. The collection of this short-term data allows the construction of longer sequences of high quality biographical information across a range of domains. The origin of panel studies was the need to explore the dynamics of poverty and income. It followed from an understanding that these could not be explored through separate snapshots, but rather required an approach which collected a continuous record about incomes in particular. This implies frequent interviews to minimize recall problems. These general statements can be broken into a range of research uses:

- 1) The analysis of the incidence of state and events such as poverty or unemployment over time, which provides a very different understanding of their distribution in society from that provided by cross-national data.
- 2) The measurement of the rates of transition between states, and the factors associated with these transitions. This analysis may be based either on repeated annual measures or on the construction of complete histories based on monthly calendars for the periods between waves. This short-term retrospective data is much more reliable than that collected from longer period life histories.
- 3) The design in which all household members are interviewed and followed permits the analysis of associations between the life course of different household members, and how their individual decisions may impact on each other. It also makes the household panel study particularly suitable for the analysis of the dynamics of household formation and dissolution, and the associated events and outcomes.
- 4) The analysis of the association between changes in the different domains, for example health and the labour market, in order both to understand causal ordering, and to understand the wider social key events and processes.
- 5) The analysis of associations between measures in a modelling context, which takes account of unobserved heterogeneity through the use of repeated measures in fixed and random effects models.

- 6) The accumulation of life history data, both within the panel itself and in the retrospective life history collected in the early waves, makes the panel particularly suited to the analysis of the long-term accumulation of resources (personal and financial), and their impact on later outcomes.

By continuing into the over the next decade and beyond, the BHPS will start to provide data on period differences in some of the short-term transition processes, for example, whether jobs and families are becoming still more unstable – something which is difficult to explore with retrospective data.

Certain new advantages start to emerge as the panel increases in length. For example it becomes possible to analyze some of the longer spells and sequences with full data on antecedents and the evolution of events during the spell. It also becomes possible to analyze the impacts of earlier life stages, including for example the impacts of childhood poverty on family disruption on later life circumstances, with information from multiple measurement points, allowing inference about impact and instability. It also becomes possible to analyze other lifetime acquisition processes, especially of wealth accumulation, so allowing for the prediction of economic circumstances in retirement. It is also becoming an important resource for the analysis of mortality.

Analyses of within household relationships and influences are also informed by better historical information on all household members. It also becomes possible to undertake analyses of inter-generational influences.

The existence of an extensive network of household panel studies, throughout Europe, in North America, means that there is already a substantial level of international comparative research, and one key goal is to expand the opportunities for such research.

The highest priority of the BHPS is the maintenance of annual measures from the original core sample. Even though there are some other emerging issues, especially concerning overall sample size, and re-sampling, the BHPS

maintains high data quality and low attrition, compared with the attrition rates of the PSID in the USA, and rather lower than the GSOEP. There is therefore no doubt about its ability to continue to provide high quality data.

The BHPS is intended as a multi-purpose study with a sample size sufficient to permit analysis of key policy relevant socio-economic groups. In addition to its academic user base, the BHPS meets most of the basic requirements for government research needs, but its sample size<sup>54</sup> is sometimes seen as too small. Both academic and government users would like to increase the resolution of the study, to allow further regional breakdowns, and to permit analysis of smaller subgroups. As part of government departments review of their data needs, Payne, White and Lakey (1999) report that 'The sample size becomes more of a constraint when the focus is a minority sub-sample: people with disabilities, those in further and higher education, women with school-age children or using childcare services and so on. Also, the proportions experiencing particular kinds of transition in any one year may be small.'

### *3.3.3 Consumption*

In contrast with the Family Expenditure Survey (FES), the BHPS does not try to give a detailed analysis of expenditures. The primary measures of nondurable consumption available in the BHPS are expenditure on total food and grocery bills, expenditures on oil, gas and electricity and expenditure due to mortgage or rent housing costs. Unfortunately, information on spending on fuel is present in most, but not all, waves while expenditures on durable goods are not recorded continuously. Thus only discrete values are available and these are not consistent with our definition of consumption. The nondurable consumption we are interested in is defined as the aggregation of expenditure on total weekly food and grocery bills. Because of the lack of other consumption information in longitudinal datasets, food consumption

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<sup>54</sup> It includes around 5000 households in the core sample.

has been used in numerous studies of household consumption behaviour<sup>55</sup>. Therefore, for each household, we use the food and grocery expenditure as a proxy for real nondurable consumption. Although food is only one component of overall household expenditures, it has the benefit of being a non-durable good which is necessary for estimating standard models of household consumption behaviour. Food spending is considered as a necessary good with small income elasticity and provides quite a strong test of consumption smoothing. If households do not smooth spending on food, they are unlikely to smooth other forms of spending (although if food spending is smoothed, it cannot be rejected that total spending falls). Despite some reservations of usage of food and grocery consumption<sup>56</sup>, the results of regressions using the BHPS food consumption variables may interest some readers.

The survey question explicitly asks about expenditure at the household level. Households are asked “*approximately how much does your household usually spend each week in total on food and groceries.*” In the first wave, they are asked to give a continuous answer; in subsequent waves, they are asked to say in which band (out of 12) their weekly food spending lays. They are told to include all food, bread, milk, soft drinks etc, but asked to exclude pet food, alcohol, cigarettes and meals out. Take-away food eaten in the home is, however, included. To obtain a weekly spending figure, each individual is assigned the mid-point of their reported band each year, adjusted for inflation in food prices<sup>57</sup>. In sum, the answers to food spending in the BHPS are continuous and range from 0 to 250. Following to Souleles (2001), changes in the number of adults and in the number of children are included in the regressions to control for the influence of household composition on food expenditures.

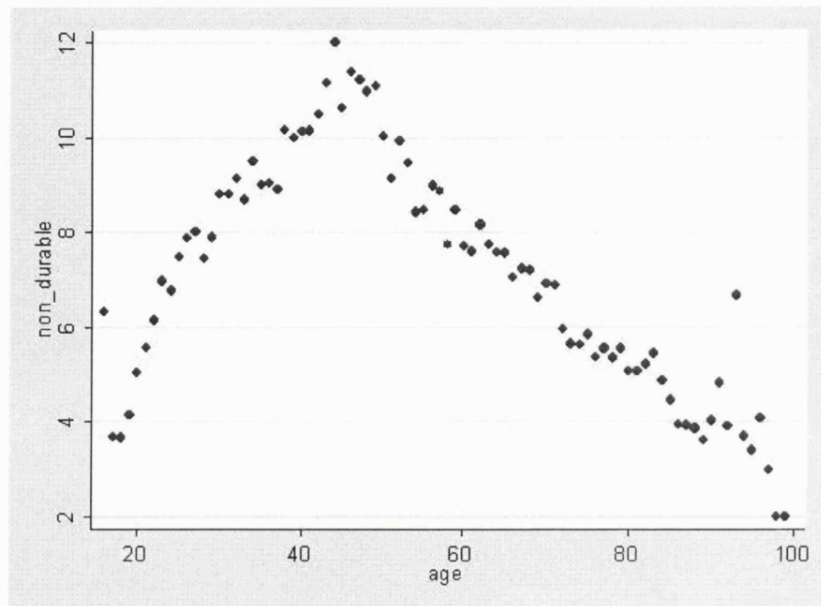
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<sup>55</sup> See, for example, Hall and Mishkin (1982), Altonji and Siow (1987), Zeldes (1989), and Shea (1995b).

<sup>56</sup> Carroll (1994) is skeptical about this strategy; Attanasio and Weber (1995) discuss the non-separability of food consumption; Shapiro (1984) states the large amount of measurement error in food consumption.

<sup>57</sup> For wave 1, the continuous answers were first banded, and then midpoints were assigned.





**Figure3.1 Household Consumption of Non-durables**

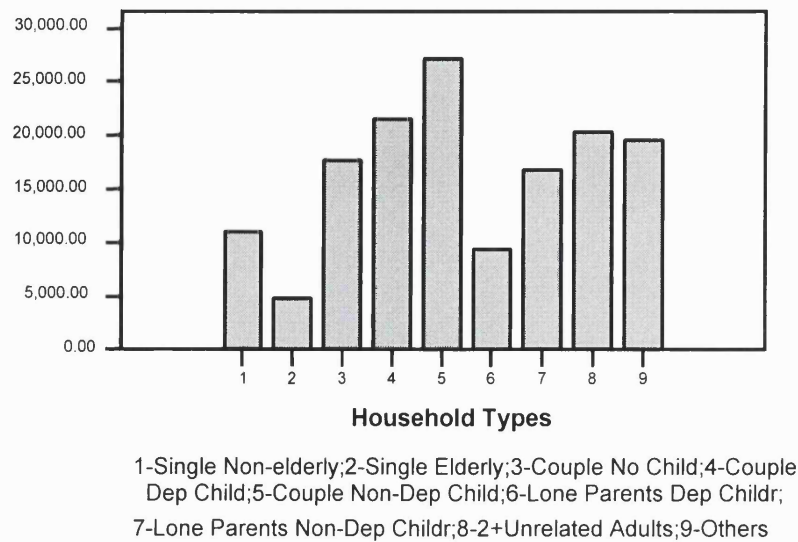
It is apparent from the above plot in Figure3.1 that household consumption rises up to an individual middle ages and starts falling thereafter. The plot reveals the much talked about hump shape or inverted ‘U’ shape of consumption over the life cycle. In the consumption literature, this plot is often used as a starting point for doubting the theoretical prediction of consumption smoothness.

#### *3.3.4 Incomes*

At the cross-sectional level, the BHPS shows the different incomes associated with different household types<sup>58</sup>. As Figure 3.2 shows, the single elderly and lone parents have the lowest incomes; couples with children have higher incomes; while comparably, couples without children have highest incomes of all.

<sup>58</sup> Single non-elderly; single elderly; couple without children; couple with dependent children; couple with non-dependent children; lone parent with dependent children; lone parent without dependent children; more than two unrelated adults; other households.

**Figure 3.2 Income Distribution**



Longitudinally, the BHPS also shows that larger numbers of respondents experience a substantial change in their income (both falls and rises) at some time in the observation periods. An example is shown in the following Table 3.1.

**Table 3.1 Change in Income Between 1991 and 1992**

Change in income between 01/09/90 and 01/09/91				
Fell 4+ deciles	Fell 2-3 deciles	Stable (-1~+1) deciles	Rose 2-3 deciles	Rose 4+ deciles
1415	316	305	253	1822
34.42%	7.69%	7.42%	6.15%	44.32%

Furthermore, the BHPS also allows us to determine the relationship between changes of income and other factors, like household composition, marriage and divorce or separation, etc. For example, Buck *et al.* (1994) find the incomes of the rich are much more likely to fall than those of the poor in using the BHPS database between 1990 and 1992. In other words, the

incomes of the poor are less likely to fall compared to those of others. In summary, because the BHPS collects income information from the same individuals each year, it is possible for us to trace the evolution of incomes over a long period of time and measure the household's or individual's wellbeing. Household income in the BHPS is defined as the combination of labour market earnings, social security benefits<sup>59</sup>, investment income, and other sources. It is strongly associated with two main characteristics: the composition of the household and the employment status of its members. Buck *et al.* (1994) also introduce the ideas of equivalent income and use income deciles to describe the distribution of income and to measure income changes. The purpose of using equivalent income is to take account the effects of changes in household composition change on needs, while income deciles are used to handle the possibility that changes in household welfare may not be linearly related to income. In this study, income is measure as the Retail Price Index (RPI) deflated annual household income. This variable is transformed into natural logarithms to allow for the concavity of the financial wellbeing/income relationship.

### 3.3.5 Financial Wellbeing Variables

The questions which this research focuses on relate to individuals expectations of their expected financial change in the coming year, the actual financial changes which take place, and a derived variable, agents' expectation errors, which is formed by subtracting the expected financial change in the previous year from the actual change in their financial position in the current year. In the BHPS, questions *Xfisitc*<sup>60</sup> and *Xfisitx* ask the individual own financial position. *Xfisitc* asks about changes over the previous year while *Xfisitx* asks for a forecast of the respondent financial situation in coming year. The responses to *Xfisitc* and *Xfisitx* are constrained to one of four categories (1-better off, 2-worse off, or 3-same, or -1-unknown). To describe the

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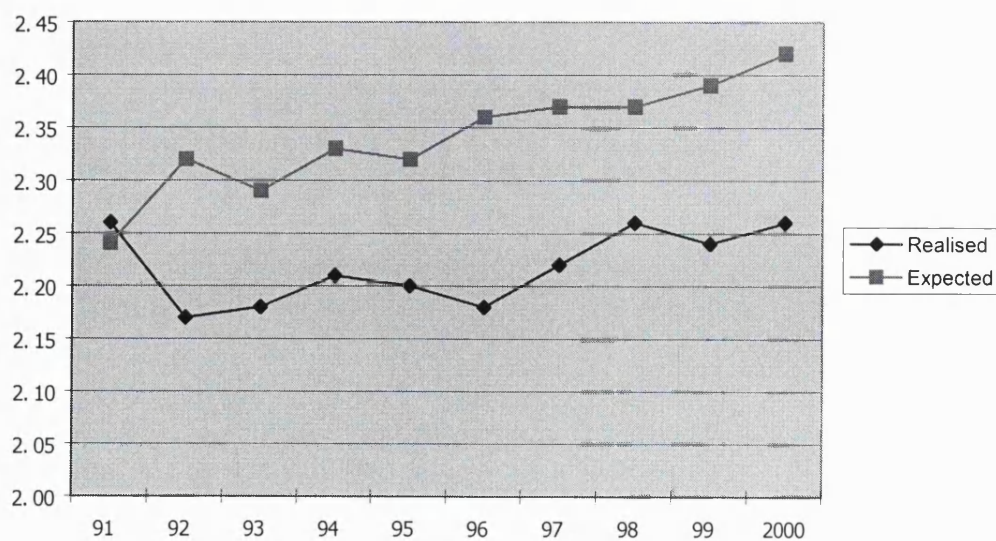
<sup>59</sup> It plays critical role to benefit elderly households, lone parents, and some household with children.

<sup>60</sup> The 'X' relates to wave number.

relationship between the individuals' expectations and their outcomes, and make the subsequent analysis easier, I recoded the financial wellbeing variables. After the process, for all financial conditions, +1 denotes the good state. I consider responses to qualitative questions asking respondents to choose among ordered-response categories. The questions are as followed and the allowed responses are in brackets.

Before I explore the profiles of expected and realized financial situation, I should note some of the dynamic aspects of the financial situation variables. There is a great deal of individual-level variation in the current financial situation responses over time with 94% of respondents changing their financial situation response at least once between 1991 and 2002. Moreover, the average spread (i.e. maximum minus minimum reported value) in the current financial situation is fairly wide at 1.81. Similar dynamics were found for the expected financial variable, with 91% (96% for the actual financial outcome) changing their response at least once with an average spread of 1.33 (1.66 for the realized financial situation). As a result, the means of cross-sectional data are calculated.

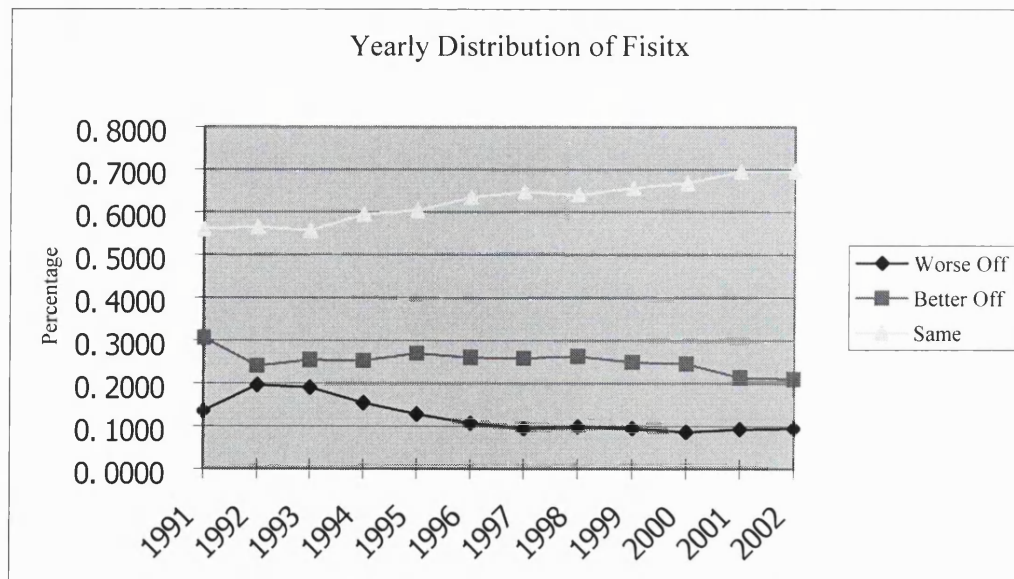
**Figure 3.3 Expectations and Realizations over Time**



In the above Figure 3.3, the wording of financial expectations questions in the year matched that of financial outcomes of the following year. Analysis found that both of these variables are neither obviously pro-cyclical nor counter-cyclical. Also, the correlation between them were not as significant as that found in Souleles's (2001) paper.

a) Fisitx. (Financial Situation Expectation for year ahead) – *“Looking ahead, how do you think you yourself will be financially a year from now. Will you be [worse than now, about the same, better than now]?”* This is a prototypical economic expectations question with each response receiving equal weight. Thus, there are three categories of expectations of financial situation change that take on three values, 1, 2, and 3. The bigger the number, the more the individual financial situation is expected to be improved. The distributions of the answers per wave are shown in Figure 3.4 and Table 3.2.

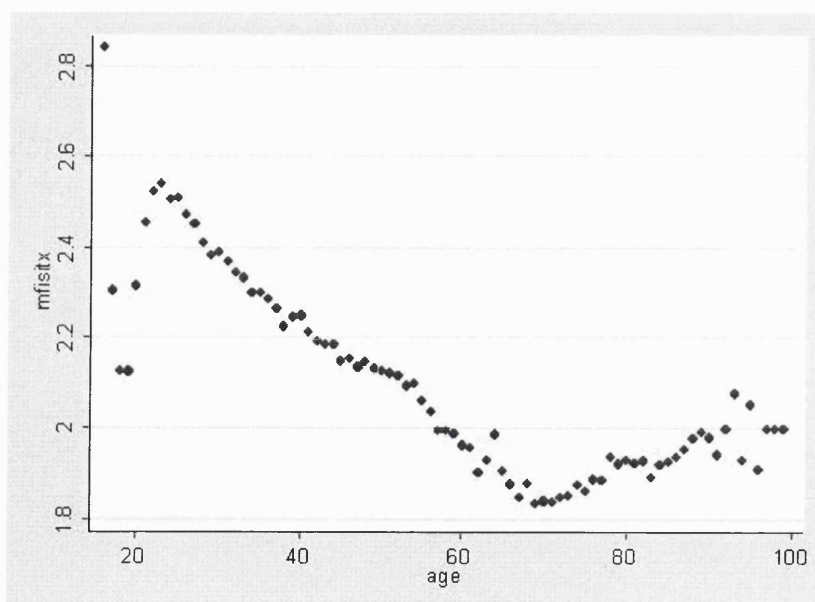
**Figure 3.4 Yearly Distribution of Expectations**



**Table 3.2 Univariate Frequencies (in %) of Financial Expectations**  
( $t=1991\dots2002$ )

<i>Fisitx</i> (#obs:3279)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1: Worse Off	0.1351	0.1955	0.1897	0.1540	0.1275	0.1064	0.0942	0.0982	0.0952	0.0863	0.0924	0.0942
2: About Same	0.5593	0.5645	0.5560	0.5938	0.6029	0.6334	0.6475	0.6392	0.6563	0.6682	0.6941	0.6959
3: Better Off	0.3056	0.2400	0.2543	0.2522	0.2696	0.2601	0.2583	0.2626	0.2486	0.2455	0.2135	0.2098
Mean	2.170	2.045	2.065	2.098	2.142	2.154	2.164	2.164	2.153	2.159	2.121	2.116

We can see that the number of respondents expecting the same beyond 50% and increase moderately with the exception of 1993 and 1998. In all cases, the proportion of respondents expecting to be better off are much more than those expecting to be worse off. These results support one of the main arguments used by Easterlin (2001) in which he argued that 'people at any given point in the life cycle typically think that they will be better off in the future than at present' (p.471). Likewise, Cantril (1965) conducted a study using data from 15 countries and found that respondents have higher forecasts and lower their past in most cases in every country.



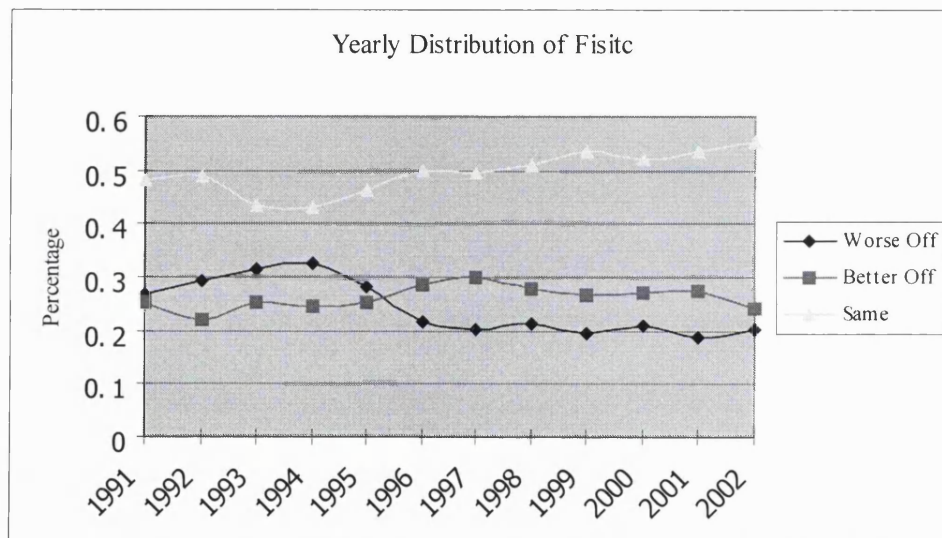
**Figure 3.5 Financial Situation Change Expectations across Age**



A plot of the financial situation change expectations vis-à-vis the age of the respondent is shown in the above Figure 3.5. It displays a hump shape in the early lifetime and a ‘U’ shape thereafter.

b) *Fisite*. (Financial Situation Realization) Individuals also answer the question ‘Would you say that you yourself are worse off (1), about the same (2) or better off (3) financially than you were a year ago?’ The numbers of observations per wave are presented in the following Figure 3.6 and Table 3.3.

**Figure 3.6 Yearly Distribution of Financial Realizations**



**Table 3.3 Univariate Frequencies (in %) of Financial Realizations**  
( $t=1991\dots2002$ )

<i>Fisite</i> (#obs:3279)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1: Worse Off	0.2672	0.2922	0.3132	0.3236	0.2821	0.2171	0.204	0.2138	0.1964	0.208	0.1894	0.204
2: About Same	0.4797	0.4883	0.4343	0.4312	0.4639	0.498	0.4944	0.5093	0.5355	0.5212	0.5358	0.5547
3: Better Off	0.2531	0.2195	0.2525	0.2452	0.254	0.2848	0.3016	0.2769	0.2681	0.2708	0.2748	0.2412
Mean	1.986	1.927	1.939	1.922	1.972	2.068	2.098	2.063	2.072	2.063	2.085	2.037

If we compare Table 3.2 with Table 3.3 we can see that the dispersion in realized financial changes is much larger than that for expected financial changes. This is not surprising, since the expected financial change refers to the respondents' subjective financial change distribution, while the realization variable is one draw from the actual distribution of financial change. The number of people becoming worse off is more than the number of people becoming better off before 1995. From 1994 the number of people realizing worse off declines sharply (almost linearly), and by 1996 it is less than the number of people becoming better off. This pattern continues thereafter. This is probably due to the macroeconomic conditions which prevailed in the UK over this period.

c) *Fisite*. (Expectation errors) With panel data we are able to compare micro data on expectations of prospective outcomes with data on realized outcomes and use these to construct individual 'expectation errors'<sup>61</sup>. That is, we can calculate expectation errors for the matched pairs of questions by taking the outcome from the second interview (provided in wave  $t+1$ ) and subtracting the corresponding expectation from the first interview (provided in wave  $t$ ). Thus, for a given respondent the expectation error regarding their financial situation is defined as:

$$fisite_{i,t} = fisitc_{i,t+1} - fisitx_{it} \quad (3.1)$$

where  $t$  refers to the first respondent interview in the BHPS data, while  $t+1$  to the second interview. As a result we can confront the three-ordered-category expectations question *Fisitx* with the corresponding three-ordered-category realizations questions *Fisitc*, both coded in  $\{1, 2, 3\}$ , give a five-ordered

---

<sup>61</sup> The vague wording of the questions might imply a possible weakness of using the term 'error'. According to habit formation effect, if someone has experienced strong decreases in the past, one may have got used to it, and won't use the word *strong* again. We find that the size of either strong optimism or strong pessimism is small. We can eliminate this problem in future by combining the categories 1 and 2 and the categories 4 and 5, so that the difference between *strong* and *moderate* is eliminated. We can then recalculate the test-statistics to investigate whether overestimation is still significant in subsequent waves.



category of expectation errors  $Fisite$  coded in  $\{-2, -1, 0, 1, 2\}$ . If  $fisite_{t+1}$  is larger than  $fisite_t$ , then we can say that the respondents *ex post* appeared to underestimate their finance growth. Analogously, if  $fisite_{t+1}$  is smaller than  $fisite_t$ , then financial growth was overestimated because of respondents' optimism. Strong optimism is coded as -2, weak optimism as -1, realism as 0, weak pessimism as +1, and strong pessimism as +2. The following Table 3.4 describes this coding scheme in more detail.

**Table 3.4 Expectation Errors Index**

	Realization ( $Fisite$ )		
	1	2	3
Expectation ( $Fisite$ )	1	0	1
	2	-1	0
	3	-2	-1

Table:  $Fisite = Fisite - Fisite$

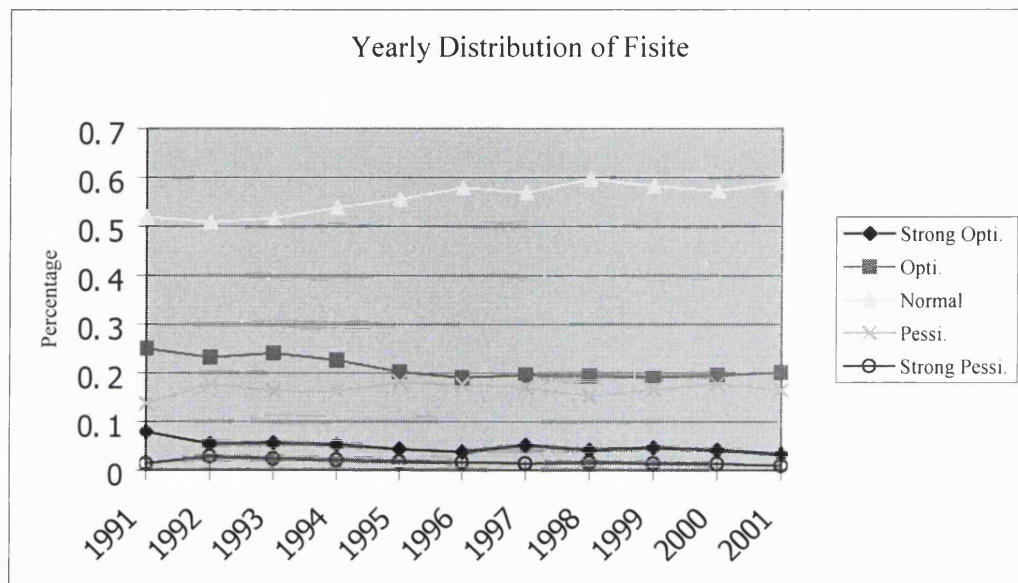
Where

-2	Strong Optimistic
-1	Weak Optimistic
0	Realistic
1	Weak Pessimistic
2	Strong Pessimistic

To make the answers more comparable, we constructed a balanced panel data, in which information on all the required variables was reported at each wave and observations were limited to respondents who answered questions every year, to explain the distribution of expectation error. The following

Figure 3.7 and Table 3.5 present the frequencies of respondents who were optimistic and pessimistic concerning their expected financial change.

**Figure 3.7 Yearly Distribution of Expectation Errors**



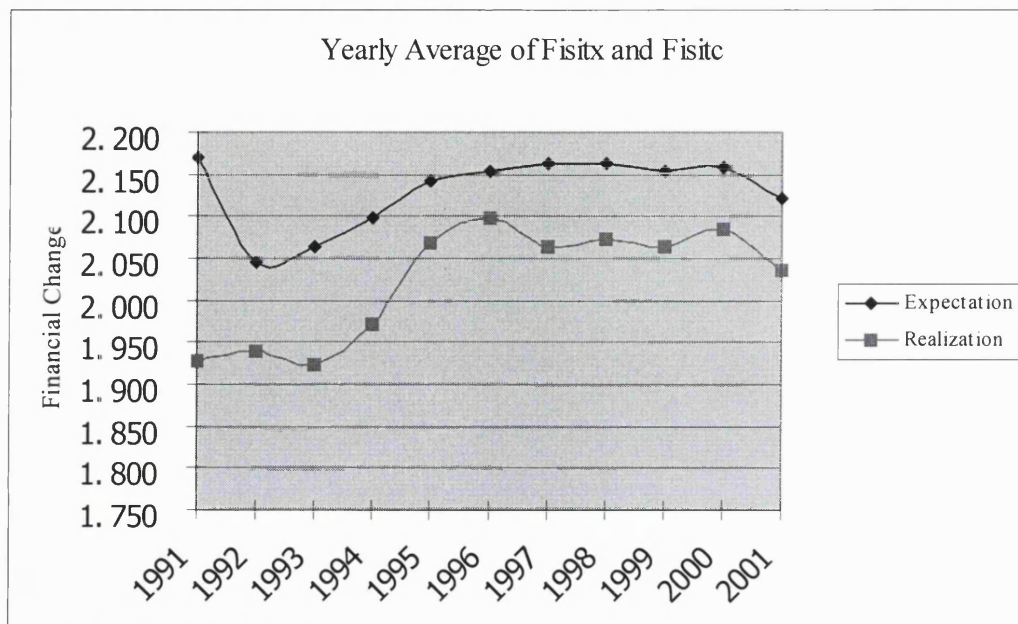
**Table 3.5 Univariate Frequencies (in %) of Expectation Errors**  
( $t=1991 \dots 2002$ )

<i>Fisite</i> (#obs:3279)	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
-2: Strong Opti.	0.0793	0.054	0.0564	0.0525	0.0436	0.0378	0.0515	0.0415	0.0464	0.0415	0.0335
-1: Optimistic	0.2501	0.2318	0.2406	0.2263	0.2025	0.1903	0.1961	0.1943	0.1918	0.1952	0.2013
0: Normal	0.5191	0.5081	0.516	0.5377	0.5557	0.5788	0.5682	0.5956	0.5819	0.5721	0.5904
1: Pessimistic	0.1375	0.1778	0.1635	0.1622	0.1812	0.1763	0.1702	0.1528	0.1659	0.1781	0.165
2: Strong Pessi.	0.014	0.0283	0.0235	0.0213	0.0171	0.0168	0.014	0.0159	0.014	0.0131	0.0098
Mean	-0.2431	-0.1052	-0.143	-0.126	-0.074	-0.056	-0.101	-0.093	-0.091	-0.074	-0.084

It shows that more than half of the respondents did not have expectation errors. This means that most respondents are realistic and that their future financial situation changes in line with their expectations (From 52 per cent to

59 per cent). In cases, we can see that the percentage of individuals overestimating exceeds the percentage of individuals underestimating their future financial changes. This negative means conclude that there are more over-optimistic respondents than over-pessimistic respondents on average.

**Figure 3.8 Yearly Average of Expectations and Realizations**



As Figure 3.8 shows, the expectations of financial situation change (*Fisitx*), and realizations of financial situation change (*Fisitc*) on a year-by-year basis. Expectations of financial situation change at  $t+1$  are far higher than realizations at  $t$  in the first 4 years of the BHPS. After that, actual and expected financial situations converged by 1995 and 1996, demonstrating that respondents quickly correct their over-optimism. The divergence between realized and expected situations reappears, but the difference does not become as big as it did in the first four years. Thus in the following years, the difference between realized and expected tends to converge. This supports one of the main assumptions of the REH, in which individuals are assumed to keep reviewing their mechanism for expectation formation until no systematic errors. However the difference never quite disappears in our

observation period. In other words, it suggests that respondents were, on average, fairly over optimistic in their expectations but corrected their expectations close to the actual outcomes. But, after nearly a decade, a significant differential still remains between expectations and outcomes. Notably, in most cases the forward-looking, *Fisitx*, appears to lead the backward-looking, *Fisitc*.

### 3.3.6 Other Variables

Demographic characteristics are important in the evaluation of lifetime consumption patterns. The most important demographic characteristics considered in this thesis are marital status (*MARRIED*, *UNMARRIED*) and the highest educational qualification attained by the end of the sample period in ascending order of attainment after recoding. It is also included the number of adults living in the household including the respondent (*HHSIZE*), and the number of children living in the household.

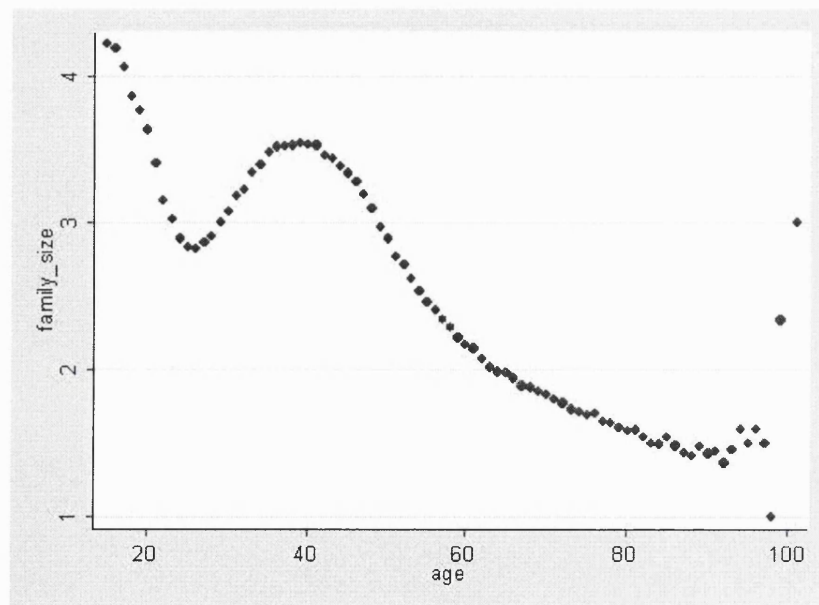


Figure 3.9: Household Size Profile across Age

The plot in **Figure 3.9** shows that family size increases until middle-age and starts to fall thereafter. As a result family size is at a maximum around 40 years of age for sample households in the BHPS. Age is included as a second-order polynomial ( $AGE$ ,  $AGE2 = AGE^2/100$ ), and a vector of time dummies are included to account for aggregate financial shocks, time-varying reporting changes and any other effects of age which are not captured by the polynomial.

### 3.4 SUMMARY

This chapter briefly describes the information on the BHPS database and gives some details of variables I intend to use in the following empirical chapters. These relate to consumption, income and financial wellbeing. The food and grocery expenditures in the BHPS are considered to be proxies for non-durable consumption expenditure in the simulations of expected income. This is because in the process of developing detailed simulation models, we were able to identify these proxies for non-durable consumption. While some economists would consider food and grocery expenditures to be fairly unresponsive to changes in purchasing power based on aggregate data. That is, the consumption of food is relatively inelastic to income. But in the level of the individual or household, it is expected that significant changes will be observed in food and grocery expenditure when there are noticeable changes in their financial circumstances and that there is also a reasonable relationship between food expenditures and a household's financial wellbeing. As a result, in this thesis, movements in the consumption of food and groceries are related to perceived changes in a household's financial wellbeing across the waves of the BHPS to explore which factors are relatively strongly associated to changes in the financial situation of economic agents.

## *Chapter 4*

# **METHODOLOGY**

### **4.1 INTRODUCTION**

The previous chapter presents the main characteristics of panel data and the properties of the interest variables in this thesis. Accordingly, this chapter summarizes the principal models of panel analysis along with some of their relative advantages and disadvantages. I also discuss a process to determine whether to use fixed or random effects models associated with panel data.

### **4.2 PANEL DATA MODELS**

Panel data models have become increasingly popular among applied economics researchers due to their heightened capacity for capturing the complexity of consumer behaviour compared to cross-sectional or time series data models. However because panel data has both cross-sectional and time series dimensions, the applications of regression models to fit econometric models are more complex than those for simple cross-section datasets.

There are several types of panel data analytic models. A general panel data model can be expressed as followed:

$$y_{it} = \alpha + X'_{it}\beta + u_{it}, \quad i = 1, \dots, N; \quad t = 1, \dots, T \quad (4.1)$$

where  $i$  denotes households, individuals, firms, countries, etc.  $t$  denotes time,  $\alpha$  is a scalar, and  $\beta$  is  $K \times 1$ , and  $X_{it}$  is the  $i$ th observation on  $K$  explanatory variables. Most panel data applications utilize a one-way error component model for the disturbances, with

$$u_{it} = \mu_i + v_{it} \quad (4.2)$$

where  $\mu_i$  denotes an unobservable unit specific effect which is time-invariant and accounts for any unit-specific effect that is not included in a regression. If  $\mu_i$  is correlated with any of the  $X_i$  variables, the estimates from a regression of  $y$  on the  $X_i$  variables will be subject to unobserved heterogeneity bias.  $v_{it}$  denotes the remainder disturbance and varies with units and time. It can also be thought of as the usual disturbance in the regression. Panel data models are generally categorized as constant coefficient models, fixed effects models, and random effects models. As an example, for a consumption function utilizing data on agents across time,  $y_{it}$  will measure expenditure and  $X_{it}$  will measure income and demographical variables. The unobservable individual specific effects will be captured by the  $\mu_i$ . We can think of these as representing unobservable individual characteristics.

#### *4.2.1 The Constant Coefficients Model*

The constant coefficients model is also called the pooled regression model. It makes the assumption that both intercepts and slopes have constant coefficients. If  $X_i$  controls are assumed to be so comprehensive that they capture all the relevant characteristics of the agent, there will be no relevant unobserved characteristics. In that case the  $\mu_i$  may be dropped and we could pool all of the data to run an ordinary least squares regression model, treating all the observations for all of the time periods as a single sample.

#### *4.2.2 The Fixed Effects Model*

There are three versions of the fixed effects approach. In the first two, the models are manipulated in such a way so that the unobserved effect is eliminated.



1) *Within-groups fixed effects*

In the first version, the mean values of the variables of the observations for a given individual are calculated and subtracted from the data for that individual. In view of  $y_{it} = \alpha + X'_{it}\beta + u_{it}$ ,  $i = 1, \dots, N$ ;  $t = 1, \dots, T$  (4.1), one may write

$$\bar{y}_i = \alpha + \sum_{j=2}^k \beta_j \bar{X}_{ij} + \mu_i + \bar{v}_{it} \quad (4.3)$$

subtracting this from  $y_{it} = \alpha + X'_{it}\beta + u_{it}$ ,  $i = 1, \dots, N$ ;  $t = 1, \dots, T$  (4.1)  $\bar{y}_i = \alpha + \sum_{j=2}^k \beta_j \bar{X}_{ij} + \mu_i + \bar{v}_{it}$ , one obtains

$$y_{it} - \bar{y}_i = \sum_{j=2}^k \beta_j (X_{ijt} - \bar{X}_{ij}) + v_{it} - \bar{v}_{it} \quad (4.4)$$

and the unobserved effect disappears. This model is called as *Within-groups regression* model because it explains the variations around the mean of the dependent variable in terms of the variations about the means of the explanatory variables for the group of observations relating to a given individual. Researchers can use this model to detect unobserved heterogeneity bias. But there are three problems in the application of this model.

- a) The intercept  $\alpha$  and any  $X$  variable will drop out of the model if they remain constant for each individual. Even after ignoring the elimination of the intercept, the loss of the unchanging explanatory variables may be aggravated. For example, if one is fitting an expenditure function to data for a sample of individuals who have completed their schooling. It is assumed that the schooling variable for individual  $i$  in period  $t$  is  $edu_{it}$ . If the education of the individual is complete by the end of the first time period,  $edu_{it}$  will be the same

for all  $t$  for that individual and  $edu_{it} = \overline{edu_i}$  for all  $t$ . Hence  $(edu_{it} - \overline{edu_i})$  is zero for all time periods. Hence if all individuals complete their schooling during the first time period,  $edu_{it}$  will be zero for all  $i$  and  $t$ . one cannot get a result from a regression model when a variable's values are all zero. In this case, we would fail to obtain an estimate of the consumer expenditure behavior in terms of schooling untainted by unobserved heterogeneity bias.

- b) The second problem is the potential impact of the disturbance term. This is because the precision of OLS estimates depends upon the variances of the explanatory variables greater than the variance of the disturbance term. However if the variance in  $(X_j - \bar{X}_j)$  is much smaller than the variance in  $X_j$ , the impact of the disturbance term will be relatively large, giving rise to imprecise estimates. The situation is especially problematic when combined with measurement error. As this will lead to bias, the greater the bias, the smaller the variance of the explanatory variable will be in comparison with the variance of the measurement error.
- c) A third problem is that one degree of freedom for every individual in the sample is lost in the model when researchers manipulate the model to eliminate unobserved effects.

## 2) *First-differences fixed effects*

The first-difference regression model is one where unobserved effects are eliminated by subtracting the observation for the previous time period from the observation for the current period for all time periods. Thus for individual an  $i$  in time period  $t$  the model can be written as following:

$$y_{it} = \alpha + \sum_{j=2}^k \beta_j X_{ijt} + \mu_i + v_{it} \quad (4.5)$$

For the previous time period, the relationship is

$$y_{it-1} = \alpha + \sum_{j=2}^k \beta_j X_{ijt-1} + \mu_i + v_{it-1} \quad (4.6)$$

Subtracting  $y_{it-1} = \alpha + \sum_{j=2}^k \beta_j X_{ijt-1} + \mu_i + v_{it-1}$  (4.6) from

$$y_{it} = \alpha + \sum_{j=2}^k \beta_j X_{ijt} + \mu_i + v_{it} \quad (4.5), \text{ one obtains}$$

$$\Delta y_{it} = \sum_{j=2}^k \beta_j \Delta X_{ijt} + v_{it} - v_{it-1} \quad (4.7)$$

and so the unobserved heterogeneity has disappeared. But the intercept and any  $X$  variables that remain fixed for each individual will disappear from the model and  $n$  degrees of freedom are lost because the first observation for each individual is not defined. Moreover, the error term for  $\Delta y_{it}$  is  $(v_{it} - v_{it-1})$  while that for the previous observation is  $(v_{it-1} - v_{it-2})$ . Thus these two error terms both have a component  $v_{it-1}$  with opposite signs and this may cause negative moving average autocorrelation. In the case that  $v_{it}$  is subject to autocorrelation:

$$v_{it} = \rho v_{it-1} + \omega_{it} \quad (4.8)$$

where  $\omega_{it}$  is a well-behaved innovation, the moving average disturbance term is equal to  $(1 - \rho)v_{it-1}$  component could be small and so the first difference estimator could be preferable to the within-groups estimator.

### 3) Least squares dummy variable fixed effects

With the assumption of constant slopes, intercepts in one of fixed effects model differ according to the *cross-sectional unit*, such as area of residence or level of educational attainment. In other words, while they are no significant temporal effects, there are significant differences in education levels in this

type of model. In this case, the  $\mu_i$  are assumed to be fixed parameters to be estimated and the remainder stochastic disturbances with  $v_{it}$  independently and identically distributed  $IID(0, \sigma_v^2)$ . The  $X_{it}$  are assumed independent of the  $v_{it}$  for all  $i$  and  $t$  such that

$$y_{it} = \alpha_i + \alpha_1 group_1 + \alpha_2 group_2 + \dots + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots + u_{it} \quad (4.9)$$

Another kind of fixed effects model has constant slopes but intercepts that differ according to *time*. In this case, the model would have no significant group differences but might have autocorrelation owing to time-lagged temporal effects. As a result the residuals of this type of model may have autocorrelation in the process. Furthermore this kind of fixed effects model also suffers from a large loss of degrees of freedom. As a result for large consumer panels, where  $N$  is very large, regression may not be feasible if it includes  $(N-1)$  dummies, because too many dummies may aggravate the problem of multicollinearity among independent variables in the regression. In this case, the variables are homogenous across the groups (e.g. they could be similar in education levels). For example, welfare policies may lead to group specific characteristics that affect the temporal changes in the variables being analyzed. We could account for this time effect over the  $t$  years with  $t-1$  dummy variables on the right-hand side of the equation. With such dummy variables named according to the time (e.g., the day, month, or year they represent) such a model could be specified as follows:

$$y_{it} = \alpha_i + \lambda_1 Year1991 + \lambda_2 Year1992 + \dots + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots + u_{it} \quad (4.10)$$

Further, there is another fixed effects panel model which assumes that the slope coefficients are constant, but the intercept varies of country as well as over time. Here we would have a regression model with  $i-1$  group dummies and  $t-1$  time dummies which could be presented as follows:

$$\begin{aligned}
y_{it} = & \alpha_i + \alpha_1 group_1 + \alpha_2 group_2 + \dots \\
& + \lambda_1 Year1991 + \lambda_2 Year1992 + \dots \\
& + \beta_1 X_{1t} + \beta_2 X_{2t} + \dots + u_{it}
\end{aligned} \tag{4.11}$$

Another type of fixed effects model has differential intercepts and slopes which both vary according to unit. We formulate this model by including both group dummies, and their interactions with their time-varying covariates.

$$\begin{aligned}
y_{it} = & \alpha_i + \alpha_1 group_1 + \alpha_2 group_2 + \beta_1 X_{1t} + \beta_2 X_{2t} \\
& + \beta_4 group_1 \times X_{1t} + \beta_5 group_2 \times X_{2t} + u_{it}
\end{aligned} \tag{4.12}$$

Finally, there is a fixed effects panel model in which both intercepts and slopes might vary according to group and time. This model includes  $i-1$  group dummies,  $t-1$  time dummies, the variables under consideration and the interactions between them.

Because fixed effects estimators depend only on deviations from their group means, they are sometimes referred to as within-groups estimators (R. Davidson, J. G. MacKinnon 1993). If the cross-sectional effects are correlated with the regressors, then the cross-sectional effects will be correlated with the group means. As a result Ordinary Least Squares (OLS) estimated based on the pooled sample would be inconsistent, even though the within-groups estimators would be consistent. However, if the fixed effects estimations are uncorrelated with the regressors, the within-groups estimator will not be efficient. However if there is only variation between the group means, then it would be permissible to use errors that are correlated with the group means of the regressors (R. Davidson, J. G. MacKinnon 1993).

The big advantage of fixed effects models are that the error terms may be correlated with the individual effects. But in most cases, fixed effects models have too many cross-sectional units of observations requiring too many dummy variables for their specification. Too many dummy variables reduce sufficiently the number of degrees of freedom to allow for the use of

adequately powerful statistical tests. Furthermore, too many variables in a model may cause multi-collinearity, which increases the standard errors and thereby drains the model of the statistical power needed to test its parameters. Finally, there could also be group-specific heteroskedasticity or autocorrelation over time even the model residuals are assumed to be normally distributed and homogeneous.

#### 4.2.3 The Random Effects Model

To avoid the loss of degrees of freedom caused by the inclusion of too many parameters in the fixed effects model and to include variables of interest that are constant for each individual, an alternative approach, known as a random effects model, is often introduced. There has been considerable interest in using random-effects models for longitudinal, hierarchical, clustered, or multilevel data in economics. In this model, each of the unobserved variables is supposed to be drawn randomly from a given distribution and this may well be the case if individual observations constitute a random sample from a given population. One example is the BHPS where the respondents were randomly drawn from British adults aged 16+ from 1991. The random effects model is a regression with a random constant term drawn from a given distribution. It is assumed that the intercept is a random outcome, which is a function of the mean value plus a random error. In this case  $\mu_i \sim IID(0, \sigma_\mu^2)$ ,  $v_{it} \sim IID(0, \sigma_v^2)$  and  $\mu_i$  are independent of  $v_{it}$ . In other words, the cross-sectional specific error term  $\mu_i$  must be uncorrelated with the errors of the variables if this is to be modelled. The random effects model is an appropriate specification if we are drawing  $N$  individuals randomly from a large population. This is usually the case for household panel studies. In panel data studies, care is taken in the design of the panel to make it representative of the population. In this case,  $N$  is usually large and a fixed effects model would lead to an enormous loss of degrees of freedom. The time series cross-sectional regression is one example of the random effects model:

$$y_{it} = \beta_i + \beta_1 X_{1t} + \beta_2 X_{2t} + \mu_i + v_{it} \quad (4.13)$$

where the random error  $\mu_i$  is heterogeneity specific to a cross-sectional unit and  $\mu_i$  constant over time. This means that, for all the observations relating to a given individual,  $\mu_i$  will have the same value, reflecting the unchanging unobserved characteristics of the individual. For  $\mu_i$  to be properly specified, it must be orthogonal to the individual effects. The random error  $v_{it}$  is specific to a particular observation. The random effects model has the distinct advantage of allowing time-invariant variables to be included among the regressors, because the model includes a separate cross-sectional error term.

#### *4.2.4 Fixed Effects Model or Random Effects Model?*

Fixed effects and random effects models were discussed in the previous sections. This section explores a model which is more suitable for panel data study which is used in this thesis. Much work, in terms the relative merits of fixed *vs.* random effects models, has been done in the panel data econometrics literature. For example, Mundlak (1961) and Wallace and Hussain (1969) advocate the fixed effects model, while Balestra and Nerlove (1966) are proponents of the random effects model. According to Mundlak (1978), it is assumed exogeneity of all the regressors with the random individual effects in the random effects model. In contrast, the fixed effects model allows for the endogeneity of all the regressors with these individual effects. In principle random effects models are more attractive because the observed characteristics that remain constant for each individual are retained in the regression model whereas in fixed effects models, they have to be dropped. In addition with random effects models we do not lose  $n$  degrees of freedom, as is the case with fixed effects models. This is why many applied researchers have interpreted a rejection as an adoption of the fixed effects model and non-rejection as an adoption of the random effects model.

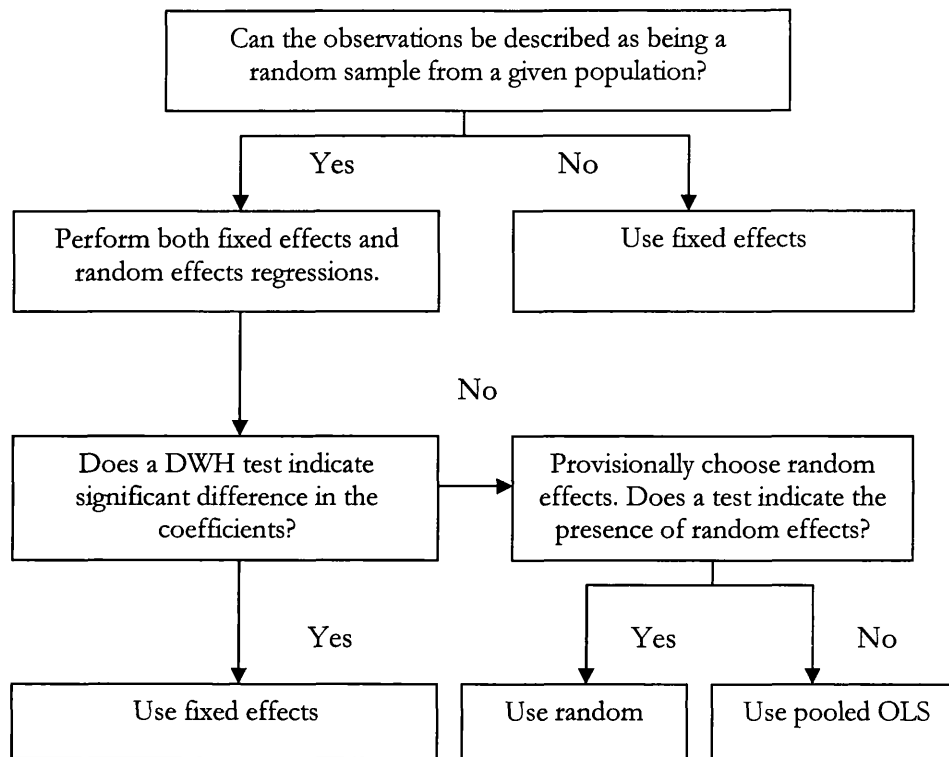
However, if either of two preconditions for using random effects are violated, fixed effects would have to be used instead. One precondition is that the observations can be described as being drawn randomly from a given population, as this has already been suggested, is a reasonable assumption in the case of the BHPS because it was designed to be a random sample. The other is that the unobserved effects are distributed independently of the  $X_j$  variables. The standard procedure where either of these occurs is an implementation of the *Durbin-Wu-Hausman (DWH)* test used to help choose between using OLS or Instrumental Variables (IV) estimation in models where there is suspected measurement error or simultaneous equations endogeneity. The null hypothesis is that the  $\mu_i$  are distributed independently of the  $X_j$ . If this is correct, both random effects and fixed effects models are consistent, but fixed effects models will be inefficient because they involve estimating an unnecessary set of dummy variable coefficients. However if the null hypothesis is false, random effects estimates will be subject to an unobserved heterogeneity bias and will therefore differ systematically from the fixed effects estimates.

As in its other applications, the *DWH* test determines whether the estimates of the coefficients, when taken as a group, are significantly different between the two regressions. They are excluded from the test if any variable are dropped in the fixed effects regression. Under the null hypothesis the test statistic has a chi-squared distribution. In principle this should have the same number of degrees of freedom to the number of slope coefficients being compared, but for technical reasons relating to the matrix algebra for required an explanation, the actual number may be lower. We can use STATA to determine the actual number of degrees of freedom in a regression application that implements the test.

In summary, it is natural to think that random effects estimation should be used when the unobserved effects can be characterized as being drawn randomly from a given population only if the unobserved effects are



distributed independently of the  $X_j$  variables and that fixed effects models should be used where unobserved effects are considered to be non-random. The following Figure 4.1 summarizes the decision-making process for fitting a model with panel data.



**Figure 4.1 Decision Making Process for Fitting a Model**

#### 4.2.5 Random Effects Ordered Probit Model

To control for individual-heterogeneity we use the random effects ordered probit model which has recently become very popular due to the increasing availability of panel data such as the BHPS (W. Arulampalam, A. L. Booth 1998;1996). The ordered probit model is one of the commonly used methodologies for estimating categorical dependent variables and has a nature order in panel data. I apply it to estimate the relationships between an ordinal dependent variable and a set of independent variables. The financial situation variables derived from the BHPS discussed in this thesis are ordinal variables that are both categorical and ordered. For instance, "improved", "same", and

“deteriorated” might be the answer to agent’s current financial status change. In ordered probit models, an underlying score is estimated as a linear function of the independent variables and a set of cut-points. In such models the probability of observing outcome  $i$  corresponds to the probability that the estimated linear function, plus random error, is within the range of the cut-points estimated for the outcome:

$$\Pr(\text{outcome}_j = i) = \Pr(\kappa_{i-1} < \beta_1 x_{1j} + \beta_2 x_{2j} + \dots + \beta_k x_{kj} + u_j \leq \kappa_i) \quad (4.14)$$

The properties of random effects ordered probit models are discussed in Appendix C.

In the following analysis, STATA 8.0 provides the “reoprobit” command written by Frechette (2001) to estimate the random effects ordered probit models. In the next chapters I examine the empirical evidence covering the period 1991 to 2002 covered by the BHPS. The likelihood ratio (LR) test statistics distributed as  $\chi^2(10)$  and the pseudo- $R^2$  are two goodness-of-fit measures I use to compare across models. The coefficient of within group error terms is denoted by  $\rho$ , which measures the significance of random effects. To save space, I do not report the coefficients of time dummies but I discuss their significance and sign in the text.

## Chapter 5

# RATIONALITY OF EXPECTATIONS

### 5.1 INTRODUCTION

The advent of the rational expectations hypothesis, which coincided with an increasing interest in optimising behaviour in economics, was a remarkable revolution in economic thinking following the Keynesian revolution of a half-century ago. As a result, numerous models and policy prescriptions based on the rational expectations hypothesis have been developed. Simon (1978) states, economics is not simply the study of the allocation of scarce resources, but increasingly the study of the *rational* allocation of scarce resources. As under the doctrine of rationality, expectations form a major part of the decision made in an economy. This chapter tests to see whether the rational expectations hypothesis is the best available objective method for modelling the form that such individual expectations take.

Most previous rationality tests have used aggregated macro data or micro data for short sample periods only. However, aggregated data can lead to spurious rejections of rationality when agents' information sets differ<sup>62</sup>, while micro data cannot efficiently average out forecast errors over a short time period even if individual forecasts are perfectly rational. For example, expectations that might have been rational *ex ante*, may not appear to be so rational *ex post*, because the sample might have, by chance, received some unexpectedly good shocks over the period. As a result, it is important to test rationality using micro data on expectations over long sample periods. Keane and Runkle (1990) and Bonham and Cohen (2001) argue that unbiased tests for rational expectations can only be undertaken using such survey data due to the existence of 'micro-heterogeneity'. This leads to a rejection of the rational expectations hypothesis with aggregate data even if expectations are rational

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<sup>62</sup> M. P. Keane, D. E. Runkle (1990)

at the individual level, since individuals make their forecasts using different information sets.

The British Household Panel Survey is unique in containing 12 years' worth of individual and household data, where a great deal of information is known about respondents at the point when they make their forecasts. As a result, while twelve years might not be long enough, the BHPS allows us to directly identify the types of individuals whose expectations are structurally incorrect. Also, I can analyse the robustness of the results over time and such a result would be as significant as a finding of irrationality, because of the available limited datasets. This chapter applies the panel facet of the BHPS to test more clearly than usual whether expectations are unbiased and efficient. I interpret the results by characterizing the type of shocks that hit different types of individuals over time. Such a characterization is of methodological interest, because both theoretical and empirical models are generally sensitive to the assumptions made about shock processes. In particular, many such models assume that "aggregate" shocks affect all respondents uniformly.

The rational expectations hypothesis does not argue that agents are always right in their expectations of future variables. Instead, the expectations error is held to be a random variable, which is uncorrelated with the other variables in the process and the information set available to the agent. Hence expectation errors are random, have a mean value of zero and a variance which is less than that associated with other models of forecasting. Thus, on average, rational expectations will be correct because the mean value of the expectations error is zero and this also means that rational expectations are the most efficient means of forming expectations, because such expectation errors have the property of minimum variance. Because of this, this chapter tests whether expectation errors are classical, in other words, whether they contain systematic components. For instance, over the sample period less educated individuals might, on average, have been optimistic about the future, and have received disproportionately positive shocks. Chamberlain (1984) and others have specified that systematic expectation errors can be a potential

problem in estimating any rational expectation or forward-looking model using short panel data. This chapter uses direct measures of individual expectation errors derived from the BHPS to test this point directly.

In empirical tests of life cycle models, direct information on respondents' future expectations is rarely used. Conversely this thesis uses the BHPS over the period 1991~2002 to directly compare survey information on what agents expect with *ex post* measures of what results: information on whether output is expected to increase, decrease or remain same over the next year is compared to similar information collected twelve months later on what actually happened. At first, this chapter explores the characteristics of expectation errors, which is done by comparing expected and realized financial status changes, to test the rationality of expectations. It then investigates how people form their expectations by identifying the factors which significantly affect respondents' subjective attitude concerning their financial wellbeing. The next chapter investigates consumer behaviours which are thought to be related to correlation between their demographical characteristics and financial expectations, financial outcome or expectation errors.

The organization of this chapter is as follows. Section 2 surveys related empirical studies. Section 3 presents the methodology for testing the rational expectations hypothesis. Section 4 presents the results concerning the rationality of expectations by exploring the characteristics of expectation errors and identifies the factors which influence respondent's expectations. Finally, section 5 presents some concluding remarks.

## 5.2 METHODOLOGY

Before exploring the characteristics of financial expectations, this thesis tests the rationality of respondents' financial forecasts, in particular their unbiasedness and efficiency, by analysing the properties of respondents' expectation errors. The approach to empirically investigating their rationality is to examine the determinants of the expectation errors between the financial expectation at time  $t$  and the corresponding outcome at time  $t+1$ . These results can also be interpreted as characterizing the shocks that, *ex post*, have hit different types of respondents over time because, up until now, in many models such shocks have been generally assumed to affect all respondents uniformly.

Unbiased expectations are those which have the same mean as the actual outcomes. There are three ways to test for the unbiasedness of financial expectations. First, many researchers assume that individuals have a perceived outcome probability distribution<sup>63</sup>. With the help of the assumption that the stated expected category is the modal category, or includes the median of the expected outcome distribution, it is possible to compare the probability of the outcome being worse than that expected with the probability of it turning out to be better than expected in terms of expectation errors. This leads to the use of nonparametric sign tests, which are used to test if the probability of falling into the single northeast cell significantly differs from the probability of falling into the single southwest cell. To use a nonparametric test, the categories 1 and 2 and the categories 4 and 5 are combined, and the middle (0's) responses are dropped by merging them into one of the other two responses (+1 or -1). Thus, the 5x5 forecast error tables are collapsed into 2x2 tables. The main problem with this is that dropping and merging categories may waste a good deal of information and that this approach makes it difficult to infer the individual or structural determinants of forecast errors. Second, expectation errors are parameterised by seeing their values (-2, -1, 0, 1, 2) as cardinal. This means that being two places off the diagonal is twice as bad as being one

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<sup>63</sup> For example, Das et al., 1999

place off. This allows us to summarize the expectation errors by regressing the errors on a constant by the use of OLS. However, whichever way this is done means that we cannot conclude that respondents are generally over-optimistic or over-pessimistic uniformly across time. Alternatively, most previous studies have used time dummies to explain all systematic heterogeneity with the strong assumption that shocks hit all people uniformly. Instead, this thesis only uses the time dummies as independent variables in regressions to test for any significant time effects in the expectation errors,  $Fisite$ , without cardinalizing them, which is suggested by Souleles (2001). The following equation  $Fisite_{it}^* = d'time_{it-1} + v_{it}$  (5.1) is estimated using the year dummies as independent variables.

$$Fisite_{it}^* = d'time_{it-1} + v_{it} \quad (5.1)$$

Where  $t$  ( $t = 1992, \dots, 2002$ ) refers to the second respondent interview in the BHPS data,  $t-1$  to the first interview.  $Fisite_{it}^*$  denote expectation errors in the wave  $t$ .

Efficiency requires that expectation errors are uncorrelated with any variable in an agent's information set at the time of forecast; otherwise the forecast does not take advantage of all the available information. Efficiency is tested by looking for systematic demographic components in respondents' expectation errors. The focus is on cross-sectional heterogeneity, because there is such variation available in the BHPS data. Specifically, heterogeneity in expectation errors will be analysed by adding the demographic variable  $Z$  to equation  $Fisite_{it}^* = d'time_{it-1} + v_{it}$  (5.1) along with the full set of year dummies as follows:

$$Fisite_{it}^* = a'time_{t-1} + b'Z_{it-1} + u_{it} \quad (5.2)$$

where  $t-1$  refers the first respondent interview in the BHPS data and  $t$  to the second interview. Since the demographic variable  $Z_{it-1}$  is known to agent  $i$  at

time  $t-1$  of forecast, efficiency requires that  $b' = 0$ .  $Fisite$  is restricted to  $\{-2, -1, 0, 1, 2\}$  so the estimate is regressed by the random effects ordered probit model.

It is noted that, in this thesis, we test the REH at the micro level by a presupposition that for market expectations to be rational all agents surveyed must be forming rational expectations. However, we know that hypothesis is based on the market, on average, having rational expectations. Thus, if my empirical test attacks on the REH at the micro level, we cannot take the result as absolute and reject the hypothesis. Manski (1990) argues the divergences between individuals' intentions and actual behaviour may not indicate the individuals are poor predictors of their future, but rather than actual behaviour may depend on events not realised at the time of the survey. Hence, predictions at the time of the survey may be the best possible given the information available to individuals at the time of the prediction. In life cycle models of individual behaviour, future expectations play an important role. Thus even if expectations based on every individual are not fully rational, they may still help forecast individual behaviour in relation to consumption or saving. This has led to an increasing interest in data on, and the empirical modelling of, individual expectations. As a result, this chapter also uses direct information on respondents' future financial status change expectations, which is different from the standard approach<sup>64</sup> found in the literature of inferring expectations from panel data on outcomes that leads to the assumption of rational expectations, to explore whether there is any evidence of micro-heterogeneity<sup>65</sup>.

This thesis used a random effects ordered probit model to investigate the characteristics of subjective data by describing the relationship between individual financial expectations, explanatory variables such as realized financial changes in the past and a set of demographical variables. To see

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<sup>64</sup> See the discussion in Guiso et al. (1992, 1996), Lusardi (1993), and Alessie & Lusardi (1996).

<sup>65</sup> Identifying the types of individuals who make the largest forecast errors and conversely to identify those individuals whose forecasts are the most accurate.



whether different social groups have different financial change expectations, it includes various dummy variables. Furthermore, it explores in more detail sub-samples differentiated in terms of gender, marital status, and education level. Since much experimental evidence indicates that expectations depend on the status quo, current financial situations are excluded from regressions which, instead, involve two dummy variables derived from financial outcomes to understand their effects on respondents' expectation. It is assumed that these take the following stacked form:

$$Fisitx_{it}^* = \gamma_1' Fisitc_{it-1}^- + \gamma_2' Fisitc_{it-1}^+ + \beta' Z_{it} + \alpha' time_t + a_i + u_{it} \quad (5.3)$$

where the index  $i$  represents the respondent and index  $t$  represents time ( $t=1991, 1992, \dots, 2002$ ).  $Fisitx_{it}^*$  denotes the financial situation change expectations in wave  $t$ .  $Z_{it}$  is a  $k$ -dimensional vector of background variables reflecting, for example, gender, age, the logarithm of real household income, and dummy variables for marriage status, smoking, housing wealth, education level, labour market status, number of children, household size, and geographic location, etc.  $\beta$  represents the coefficients vector  $Fisitc_{it-1}^-$  and  $Fisitc_{it-1}^+$  which represent the realized financial deterioration and improvement in wave  $t-1$  respectively. It means that the prediction  $Fisitx_{it}^*$  given in wave  $t$  depends on the realized financial change  $Fisitc_{it-1}$  the respondent has experienced during the past twelve months. It may also reflect a psychological effect of past financial changes on future expectations. This effect should not be present if the assumptions of the rational expectation hypothesis (REH) are satisfied ( $\gamma_1' = \gamma_2' = 0$ ).  $a_i$  is an individual effect which is assumed to be a random effect, and distributed with mean zero and variance  $\sigma_a^2$ .  $u_{it}$  is an error term and assumed to follow a distribution with a zero mean and variance  $\sigma^2$ . Year dummies  $time_t$  are included to control for business cycle effects and allow for macro-economic shocks, assumed to be common for all respondents, and not varying with  $Z_{it}$ ,  $Fisitc_{it-1}^-$  or

$Fisitc_{it-1}^+$ . For all the financial questions, larger values of  $Fisitx_{it}^*$  reflect better states. In the preliminary analysis I investigate the effects of background (demographical) variables and realized financial changes in previous time periods on respondents' expectations of financial change over time.

### 5.3 RESULTS AND ANALYSIS

This section tests the rationality of expectations and analyzes the properties of households' expectation errors and expectations. To start with, the demographical variables in my regression included race. But, after dropping observations with item non-response, most of answers to the race question were inapplicable. As a result, race was excluded from the demographical variables considered. As a result, the following analysis controls for the following individual and household characteristics: age, real household income, marital status, gender, smoking behaviour, housing wealth, educational attainment, employment status, number of children, household size, and geographical region.

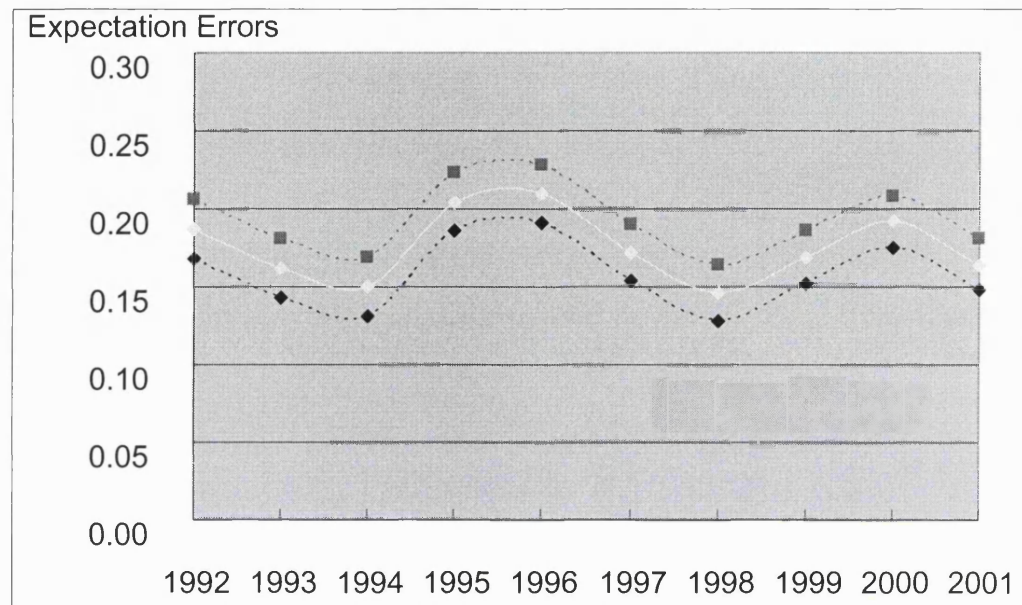
#### 5.3.1 Expectations Rationality Tests

We start by testing the unbiasedness of financial change expectations. To do this equation  $Fisite_{it}^* = d'time_{it-1} + v_{it}$  (5.1) was estimated for the whole sample and for various sub-samples based on both the unbalanced and balanced database. Because the results from both databases are similar, we report the one based on the unbalanced database. The resulting coefficients and standard deviations for the whole sample are graphed in Figure 5.1. For discrete expectation errors the chi-squared tests implied that the year dummies were jointly significant, suggesting there is significant variation in respondents' financial expectation errors from year to year, except the model in the case of 'others' in the education sub-sample. These findings accord with the Dutch evidence reported by Das and Van Soest (2001). Regression results controlling for time effects were, therefore, reported in all instances except the 'others' case.

As Figure 5.1 shows, financial change expectation errors are found to be consistently positive throughout the 12 years for the whole sample, suggesting that people were continuously and positively surprised over the period. In short, the respondents' financial expectations appear to be significantly biased.

The coefficient of cross-correlation  $\rho$  is strongly significant across samples, suggesting there is significant heterogeneity effect.

**Figure 5.1 Unbiasedness Test**



Whole Sample (unbalanced): #obs=94094, LR Chi2(10)=186.84,  $\rho = 0.103$ .

Source: Derived from the British Household Panel Survey.

That is, respondent expectation errors appear to be biased. But, it requires many years, even decades, to distinguish whether they are biased *ex ante*, or just *ex post*. The bias is problematic for empirical studies with short sample period in either case. In particular, individual expectations have higher-frequency systematic patterns in expectation errors. The results based on the different demographic groups are present in figures in Appendix A.

Turning to the efficiency of financial change expectations, I used equation

$$Fisite_{it}^* = a'time_{t-1} + b'Z_{it-1} + u_{it} \quad (5.2)$$

to estimate the results based on the unbalanced sample. These are shown in Table 1 in Appendix B.

The pseudo  $R^2$  s are small, implying that expectation errors are largely unsystematic. However, the demographic variables are jointly significant according to the chi-squared statistics, which is counter to the assumption of efficiency. The errors tended to be especially positive on average among those on high incomes, in paid employment, married couples, female-headed households and those with no children. They were also more positive among those living in East Anglia, Yorkshire or the North. However, the errors were more negative among older respondents, smokers, and those purchasing their house on a mortgage. Meanwhile the overall average expectations error was negative shown in Table 3.5, the bias in financial status change expectation tended to increase with some demographic variable like age, number of children, and unemployment status.

In summary, while this analysis of the deviation between financial expectations and outcomes suggests that the assumption on rational expectations or absence of macro-economic shocks are invalid, whether this can be interpreted as evidence of “irrationality” is a subtle issue. Because we assume that time dummies capture all systematic components of forecast errors, the results can be interpreted by the *ex post* shocks. It could be that the young, those on low incomes, smokers, those paying a mortgage, the unemployed, and parents, have perfectly rational expectations *ex ante*, but *ex post* have received disproportionately more bad or good shocks over the sample period. This is consistent with the literature that finds evidence of increasing inequality over the period, in part due to skill-biased technical change<sup>66</sup>. The assumption in empirical studies that time dummies capture all systematic components of forecast errors makes the *ex post* interpretation of the results problematic. The inefficiency of financial expectations is hard to explain and more likely represents *ex ante* inefficiency.

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<sup>66</sup> Cutler and Katz (1991); Attanasio and Davis (1996)

### 5.3.2 Financial Expectations

This section presents the relationships between financial change expectations and the perceived financial change outcomes. It uses a random-effect ordered probit model to investigate the characteristics of subjective data by describing the relationship between an individual's financial expectation and explanatory variables including past realized financial changes and a set of demographical variables. To see whether different social groups have different financial change expectations, it also included various dummy variables. Furthermore, it explored various sub-samples based on gender, marital status, and educational attainment. Since much experimental evidence indicates that expectations depend heavily on the status quo, the current financial situation is excluded in the regressions, which instead use two dummy variables derived from past financial outcomes to understand their effects on respondents' expectation. The results are shown in Table 2 of Appendix B, which presents the effects of realized financial improvements or deteriorations on individual's financial change expectations. The total number of observations in the sample is 72921. No restrictions were imposed upon the slope coefficients across the various waves.

The relationship between financial change expectations and background variables is set out in Table 2 (Appendix B). The effect of *Deteriorated* (-0.21) is significantly negative and the effect of *Improved* (0.36) is significantly positive for the whole sample. It implies that those who experience financial change deterioration in the past have a higher probability of expecting further financial change deterioration than others. On the other hand, those who experience financial change improvements tend to have higher expectations for their financial change. In other words, it means that expected financial changes can be predicted with some certainty by previous financial change outcomes. Individuals having experienced deterioration (improvement) have a higher probability of being financially pessimistic (optimistic). In terms of the magnitude of the effects, the estimated coefficients on the control for financial optimism in the previous time period outweigh those for financial

pessimism are statistically different from them at the 15 per cent level, there seems to be a persistent asymmetry in how individuals evaluate the effect of financial gains and losses on their future financial wellbeing. People are likely to have higher expectations when their situation improves, and refuse to expect worse outcome even when they had become worse off in the past. This result can be potentially helpful to explain loss aversion in economic behaviour if expectation affects consumers' choice.

The results from the sub-samples are also presented in Table 2 in Appendix B. It shows that men's expectations are more sensitive to both improvements ( $0.32$  v  $0.30$ ) and deteriorations ( $-0.10$  v  $-0.05$ ) than those of women. It means the past experience impacts more on male respondents. In addition, the magnitude of the effect of realized improvements and deteriorations on the subject's expectation is not symmetric either. Similarly, the realized changes influence the expectations of the married and the highly-educated respondents more than those of the unmarried, and those with only a secondary education level, respectively. In other words, married people, or the highly educated, were more sensitive to realized financial changes. In addition, the realized improvement has a greater effect on expectations than realized deteriorations in both cases. It is noted that realized deteriorations do not influence the expectations of the respondents with secondary education level. In other words, there is no difference between realized deterioration and realized non-change when individuals with secondary education level form their expectations. The asymmetry of response is more evident when I consider the schooling effect.

Generally speaking, the family has been the traditional source of protection against the economic consequences of uncertain events. This is because the economics literature has demonstrated that marriage partners can be made strictly better-off, provided their incomes are not perfectly correlated. However the above analysis shows exactly the opposite: being married was associated with a lower expectations comparing to those of the unmarried. The effect ( $-0.10$ ) is statistically significant using a  $t$ -test. This result may be

explained by the extent to which families depend on market conditions. In countries with developed welfare systems, providing good medical or unemployment insurance, one does not need to rely on one's spouse to enjoy increasing returns or to pool risks. Furthermore, establishing a new household involves considerable start-up costs (for the ceremony itself, the purchase or rental of a new house, furniture, household equipment, etc.), while the maintenance cost of a new household may in the early years be higher than those borne by the two families of origin. On the other hand, it could also explain why the unmarried decrease their expectations more as they age relative to the married. This should have been the case in UK. The gap in expectations between the married and the unmarried among the higher-educated group (-0.08) is less than among the secondary-educated group (-0.12). This means the secondary-educated are more sensitive to changes in their marital status, and lower their expectation more than the highly educated after they get married. Also, the gap in expectations between women and men among the married group is less than the gap among those in the unmarried group. The possible explanation is that marriage does make women feel a bit more dependant over their future.

Females tended to have lower expectations than males: the coefficient for women (-0.06) was negative and significant. This result is similar to that found by Barskey *et al.* (1997) and Donkers *et al.* (1999). At a deeper level, there may be biological reasons, with women's position in procreation relative to men's requiring them to be more risk averse. An explanation for why females are more prudent may be because they dispose of 'household income' rather than their 'own income'. We could use working female in future regressions instead simply their gender in further investigations. If the explanation of females being more risk averse is because they do not work, it would be expected that the coefficient of working female would be significantly different from the coefficient of simply being female. If this were not the case, it would suggest that female risk aversion is not related to having no income of their own. However, the results present that there is not significant difference between



highly educated women and highly educated men when they make their expectations.

Although the above results show higher education gives women more confidence in the process of forecasting their future, there is no significant difference between the highly educated and those with secondary education level in the samples.

Age is generally used as a proxy for unobserved social status, health and cohort effects. The analysis found that age had a small negative effect (-0.041) on financial change expectations. Individual expectations decrease as their age increases. There are a number of potential explanations for this: that the old are not happy the longer they live; the old feel less in control of their environment; or have lower aspirations, which are hence easier to meet (A. Cambell *et al.* 1976). The coefficients of age were significantly different between the married (-0.036) and the unmarried (-0.051). This suggests that although the married have lower expectations at a point in time relative to the unmarried, the unmarried were more likely to lower their expectations more quickly than the married with increasing age. Similarly, considering the schooling effect, highly educated people decreased their expectations with age more quickly than people of the secondary education level.

The results found significant negative effects for real household incomes (-0.03) on individual expectation, as might have been expected, in either the whole sample or some of the sub-samples. The negative coefficient means that, for such people, financial optimism is negatively associated with income. A 1 percent increase in income raises the probability of being financially pessimistic by around 3 per cent. The higher their household income in the past 12 months, the worse the financial situation expected in the coming year. Furthermore, when a variable to capture income variance was included in the regressions, its coefficient was significantly positive in all cases, although very small. This result conflicts with the general idea that those with higher 'permanent' incomes are, on average, more likely to be optimistic than others.

There is a strong positive relationship between being a smoker and an individual's expectations. If smoking is viewed as a proxy for risk-aversion, smokers might be considered to be risk-lovers who have higher expectations. Another explanation is that smoking alleviates the smokers' stress and this leads them to have higher expectations of the future than non-smokers. In the gender sub-sample, although the female have lower expectations in the whole sample, smoking behaviour pushes their expectations much more than the male. In other words, smoking behaviour can diminish the gap in expectation between the female and the male. Also, smoking leads a diminishing gap between the married and the unmarried. For highly educated smokers, they have lower expectations relative to those with secondary education level.

Housing wealth had a significant effect on individual's expectation or respondents owning their own home had significantly lower expectation than non-owner, while respondents with a mortgage had the highest expectations than all others in the whole sample. The possible explanation is that respondents with a mortgage are confident of their improved future financial wellbeing and consequently prefer take out mortgage to support their housing. However, the secondary educated with a rent have higher expectations relative to others.

Five types of labour supply status were considered in the analysis: paid employment, self-employment, unemployment, retired, and various forms of economic inactivity. The largest effect is from unemployment, where unemployed individuals have a 36% higher probability of being financially optimistic, relative to paid-employment. The retired had the lowest expectation. This conflicts with the view that the unemployed have to persistently lower their expectations because of the strong causal relationship between past and current unemployment shown by Arulampalam *et al.* (2000). One explanation for this is that it reflects their higher expected chances of finding a job due to an upswing of the business cycle, or unemployed individuals believe that their job search will be successful within a year. The unmarried and the secondary-educated exhibited a greater attachment to

being unemployed than the married and the highly educated respectively, related who tended to be in employment.

There is considerable evidence of a strong negative correlation between household size and income per person in developing countries. As a result, it is often concluded that people living in larger and (generally) younger households are typically poorer. The poor also tend to devote a higher share of their budget to essential goods. But because certain goods (water taps, cooking utensils, firewood, clothing and housing) allow for the possibility of sharing or bulk purchase, i.e. economies of scale, the cost per person of a given standard of living is lower when individuals live together than apart. In this analysis, individuals living in medium-sized households had higher expectations compared to those in smaller and larger households, while those in the smallest households had the lowest expectations. However it is interesting to note that the unmarried living in large households had lower expectations than others, while the married living in large households had the highest expectations in similar circumstances. One reason for this is that the unmarried focus on the household's costs, while the married focus on the emotional aspects of family life. Female respondents lower their expectations more than male if their household size changes from medium to small. Conversely, if their household size changes from medium to large, the female lower less, relative to the male. Considering the previous results, we found that the female usually have lower expectations, which indicates that the female also take into account the emotional aspects of family life, and large household size can increase their expectations. There did not appear to be significant difference in expectations by household size for respondents with only a secondary level education.

Similarly, this analysis found that respondents with two children were the most optimistic in the whole sample and sub-samples. One explanation for this is that the subsidy from government is the same or greater than the family costs for two children. In terms of marital status, the unmarried people with more than two children had the lowest expectations. It was not significantly

different for their expectations if the number of children was not more than two. Interestingly, the birth of the first baby will lower the expectations of the secondary-educated, but after the first born, more children make their expectations recover, and then have no further positive influence thereafter. In all cases, parents with two children had the highest expectations.

Individuals living in both East Anglia and Wales have the highest probability of being financially pessimistic. For social group of female, women living in Scotland have the highest probability of being financially optimistic comparing to women living in other areas. Individuals living in Wales have the highest probability of being financially pessimistic cross the highly-educated respondents.

### *5.3.3 Properties of Financial Expectation errors*

The previous section explained why different social groups have different financial expectations, and showed who have higher or lower expectations. This section identifies who were rational, and who usually made mistakes in forecasting their future, by analysing the characteristics of financial expectation errors in more details. This is important to aid our understanding of the ability of respondents to foresee and adjust to impending financial status changes. We added financial change outcomes in the wave  $t-1$  into equation  $Fisite_{it}^* = a'time_{t-1} + b'Z_{it-1} + u_{it}$  (5.2) in line with the regression of financial expectations. Table 3 in Appendix B shows that most independent variables are significant at the 95% confidence level. The coefficients of financial change outcome come in with the expected sign in the samples. This suggests that financial outcomes have a strongly positive relationship with respondents' expectation errors. Individuals significantly overestimate their expectations when they realize that their financial position has worsened over the past 12 months, while those whose financial situation has improved have a larger probability of underestimating future increases than others. Relating to the coefficients of expectations in the previous section, I find that even the realized improvement increases respondents'

expectations but the actual improvement is still underestimated. Similarly, the actual deterioration is greater than respondents expect when they have experienced deterioration. In short, the magnitude of improvement and deterioration are both underestimated. Further, the magnitude of this effect is also significantly asymmetric: the magnitude of the negative effect of *Deteriorated* (-0.21) is significantly less than that of the positive effect of *Improved* (0.31). The most plausible explanation of this is that those respondents whose financial situation have deteriorated are either too optimistic about the future, or are more likely to view these negative financial changes as temporary.

Furthermore, the demographic variables are also economically significant. For instance, the expectation errors are about 4.7 percentage point larger (more positive) for married respondents, relative to the unmarried. Similarly, the errors are about 9.4 percentage points larger for female, relative to male. As a result, married women (0.07) were more pessimistic than married men (0.05) in this analysis, because the magnitude of expectations, which men (-0.13) and women (-0.12), decrease, were nearly same relative to the unmarried. In terms of education sub-samples, the married with a secondary education level, appeared more pessimistic than unmarried, because they had lower expectations. The interesting point is that the highly educated married have lower expectations than the unmarried, but they do not appear more optimistic or pessimistic. Also, the highly educated women and men have the same expectations, but women were found to be more pessimistic than men. At the same time, there is no significant difference across education level in the whole sample.

The coefficient of age becomes insignificant in expectation errors regression, while it is significantly negative in expectations regression. It means that although respondents' expectations decrease with their age, the change in their age will not influence their ability to make expectations. The coefficient of income is positive. It means that individuals feel financially over-pessimistic

with the increase of income. Considering the sub samples, the highly-educated individuals are less over-pessimistic.

Smokers are more optimistic than non-smokers in all samples, and this result could be consistent with the view that smokers are considered as risk-lovers. Smokers with only secondary level education are more optimistic than those who were highly educated. Smoking behaviour can be considered as an important factor indicating individual's optimism.

Respondents who rent are more pessimistic relative to both those owning their own home, or non-owners, in the whole sample, although they have higher expectations than home owners. In other words, they usually receive more *ex post* good shocks, or have lower *ex ante* expectations relative to others. Further, the actual financial improvement of home owners is less than others; since home owners have the same expectation errors as respondents with a mortgage, while they have the lowest expectations. However, the secondary educated with a mortgage are more optimistic than those who rent, even though they have lower expectations than the latter. The unemployed have highest expectations, and are the most optimistic, while the in-paid-employment sample members were the most pessimistic. This result is consistent in all samples. As a result, unemployment can also be considered to be an important factor indicating over-optimism.

In relation to the number of children, one child is jointly significantly negative. This means that respondents with only one child are more optimistic than others, although respondents with two children have higher expectations. But women with two children appear more optimistic than other women, because they have obviously higher expectations. Another exception is the secondary-educated with two children, who are the most optimistic.

In the whole sample, there are no significant differences of forecast errors among respondents living in different-sized households, even people living in small households have lower expectations. In the female sub-sample,

respondents in medium household size appeared more optimistic than those in other household size. Men, and the unmarried in big households, appear more pessimistic

The differences between regions are not significant in the whole sample, except that people living in East Anglia and Yorkshire are more pessimistic than those in other regions. Considering male sub-samples, there is no region appearing more pessimistic or optimistic than the others. But, for female, women living in Wales and Scotland are more optimistic than those living in other regions. Similarly, the unmarried living in the Southeast, and Yorkshire, are more optimistic.

## 5.4 CONCLUSION

This chapter analyzes the subjective data on financial expectations and compares them to the outcomes using the BHPS covering the period 1991-2002. Its main findings are as follows. First, the number of people overestimating future financial changes is larger than the number of people underestimating them. This suggests that people's expectations are not rational, as agents whose financial situation has deteriorated are systematically too optimistic, or view negative financial changes as temporary. Second, those people whose financial situation has improved in the past tend to be more sensitive than those whose financial position change has deteriorated. This result, potentially, can explain the asymmetric nature of consumers' behaviour in terms of loss aversion in the consumption literature. Thirdly, the expectations of men, the married, and those with only a secondary level education, are more sensitive to their financial outcomes than others. Fourth, with respect to expectations, there are no significant relationships between real household incomes and an individual's expectations. The married are more pessimistic than the unmarried, but marriage can alleviate people's pessimism over the time scale, or make women and smokers more optimistic. However women and the highly educated individuals generally have comparatively lower expectations, while individuals living in medium sized households, or those renting accommodation, with two children, or who are currently unemployed, have relatively higher expectations than the others. Fifth, comparing the expected and realized financial outcomes over the same time period suggests that the married, women, the paid employed, and people living in smaller households, are more pessimistic than others, whilst smokers and the unemployed are over-optimistic. In addition, individuals with only one child find it easier to be over-optimistic generally, but the results are different in the different sub-groups.



## *Chapter 6*

# **EXCESS SENSITIVITY TESTS**

### **6.1 INTRODUCTION**

The arguments over the PIH/LCH and the rational expectations extension of it, concerning suggestions of excess sensitivity of consumption, have been continued for decades without an explicit solution. This is because there have been no conclusive findings in empirical studies. Most empirical results show confidence in supporting one or rejecting the other. This vagueness has significant and negative consequences for understanding the consumption/savings processes of households and for improving our knowledge of economic trends and stabilization from a policy perspective.

In the literature, many researchers have carried out investigations to test the validity of assumptions such as hyperbolic discount rates<sup>67</sup>, binge augmented consumption, habit persistence, and the excess sensitivity of consumption to income. However, only a few empirical papers have investigated the impact of individual subjective information on economic outcomes. Thus, we explore whether expectations are useful in predicting consumption behaviour in this chapter.

The methodology developed by Souleles (2001) to test for excess sensitivity with respect to household data has a deep intuitive appeal. Rather than testing excess sensitivity using aggregate data, Souleles used US household-level data from the Michigan Index of Consumer Sentiment. He found that consumer sentiments were useful in forecasting future consumption, even after controlling for lagged consumption and macro variables such as stock prices.

In this chapter, I follow Souleles (2001) by using data derived from the BHPS. This contains questions on the expected level and changes in a number of relevant economic variables and British respondents' uncertainty in making

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<sup>67</sup> People value present more than the future, as in Laibson(1997).

these predictions covering the years 1991 until 2002. One of the main novelties of this thesis is that it uses the financial situation validated in the BHPS to value the respondents' wellbeing, instead of the term 'income' popularly used in most papers. This is particularly interesting, due to the potential relationship between macro-economic shocks and individual psychological wellbeing. Thus, while a narrow interpretation of financial situation is income, a broader interpretation would take into account the values of any assets agents hold, and the incomes they currently received, or expect to receive in the future. Most interesting, some who experience an increase in current income may feel themselves worse off financially. This is similar to the results in chapter 5, in which respondents' expectations decrease with increasing real income. In other words, the idea of an agent's financial situation or satisfaction can potentially include many factors that are difficult to identify, or value, but can significantly affect agents' decision-making behaviour in the real world. Furthermore, Das and Van Soest (1996) argue that subjective answers reflect real, rather than nominal, changes. Although the questions in the BHPS are not very well specified, it seems reasonable to assume that respondents have the same broad concepts in mind when answering questions on their financial outcomes and future expectations. In each wave of the BHPS, agents answer questions on whether their actual financial situation has changed in the past twelve months, and on whether they expect it to change over the next twelve months. Both questions are answered on a three points scale<sup>68</sup>. In addition, the following analysis breaks down the whole sample into various sub-samples, to test for excess sensitivity among each of these groups. It is hoped that these results can provide a deeper insight into the divergence of sensitivity of each individual component to consumption fluctuations.

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<sup>68</sup> 1 = worse off; 2 = about the same; 3 = better off

## 6.2 METHODOLOGY

Hall's random-walk hypothesis of consumption argues that if agents have rational expectations (that is, if they are forward-looking) then current consumption should only depend on consumption in the most recent period, and that no other variables will feature in equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) of Chapter 2. The implication of the REPIH is that if all past and predictable information is incorporated in current consumption, no lagged information can provide additional explanatory power in accounting for variations in future consumption. Thus, one way to test the predictions of the REPIH is to examine whether consumption is sensitive to anticipated changes in interested explanatory variables, such as income. This approach has been taken by Hall and Mishkin (1982), Altonji and Siow (1987), Attanasio and Browning (1995) and Lusardi (1996) among others. As a means of testing the impact of lagged variables on consumption, regression equations of the following form have been introduced:

$$\Delta c_{t+1} = \beta E_t(y_{t+1}) + \varepsilon_{t+1} \text{ or } \Delta c_{t+1} = \beta E_t(y_{t+1} - y_t) + \varepsilon_{t+1} \quad (6.1)$$

where  $y$  is household real income. If theoretical predictions of the permanent income model and rational expectations are valid then  $H_0 : \beta = 0$ . In many studies (eg. Hall, 1978; Zeldes, 1989; Jappelli et al., 1998) the (log) level of income is used. Attanasio and Weber (1993) used the growth in income. It is noted that the income term can be considered as predictable income or income growth in  $t$  or  $t+1$ , using instruments dated  $t-1$  or earlier. The Euler equation is a period-to-period arbitrage condition and therefore does not take into account the effects of future constraints on current behaviour. As such, the Euler equation is a minimal test of the REPIH. In addition, problems can arise when estimating Euler equations using panel data. Chamberlain (1984) states that "a time average of forecast errors over  $T$  periods should converge to zero as  $N \rightarrow \infty$ . But an average of forecast errors across  $N$  individuals

surely need not converge to zero as  $N \rightarrow \infty$ ; there may be common components in those errors, due to economy-wide innovations.” As a result, a set of time dummies are also included in equation  $\Delta c_{t+1} = \beta E_t(y_{t+1}) + \varepsilon_{t+1}$  or  $\Delta c_{t+1} = \beta E_t(y_{t+1} - y_t) + \varepsilon_{t+1}$  (6.1) to guard against this problem in many empirical studies<sup>69</sup>. Altug and Miller (1990) claim that these dummies can be interpreted as the undiversified aggregate risk facing intertemporal decisions under a complete market setting. Although the panel data (1991-2002) employed in this thesis is longer than that used in some earlier studies, the time dimension may still not be long enough. As a result, time dummies are included in the regressors.

In life cycle models of individual behaviour, future expectations play an important role. Even if expectations are found not fully rational in previous chapters, it is believed that they may still help in making forecasts of individual behaviour in consumption or saving. This has led to an increasing interest in data on, and the modelling of, expectations. The preceding discussion has clearly indicated that standard theoretical predictions are prone to dismissal, primarily depending on the information sets the household faces. Any assumption on the homogeneity of preferences and information sets the households face might lead to inefficient evaluations. To deal with this shortcoming, Souleles (2001) came up with a simple but novel way of estimating consumption patterns by exploring the response of different types of households over time. In this chapter, following on from Souleles (2001), direct information on respondents’ future financial change expectations, which are different from the standard approach<sup>70</sup> of inferring expectations from panel data on outcomes that leads to the assumption of rational expectations are used, to test for excess sensitivity.

In this analysis, the individual’s financial variables are used as a proxy of income to explore the relationship between financial wellbeing and household

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<sup>69</sup> Zeldes (1989), Altongji and Siow (1987), and Runkle (1991)

<sup>70</sup> See the discussion in Guiso et al. (1992, 1996), Lusardi (1993), and Alessie & Lusardi (1996).

consumption. To an extent, the current income shock  $y_{t+1} - E_t y_{t+1}$  has taken the place of the financial expectation errors. Financial expectations change is related to future income expectations change  $E_t(y_{t+1} - y_t)$ . This chapter follows Souleles' (2001) method to test for the excess sensitivity of consumption to changes in financial expectations. To do this, Souleles added the lagged expectations variable  $Fisitx$  to a standard linearized Euler equation for consumption. Thus, for household  $i$ , the change in consumption between period  $t+1$  and  $t$  is specified as

$$\Delta c_{i,t+1} = \alpha time_{t+1} + \beta Fisitx_{i,t} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.2)$$

The coefficient equation is estimated in differences the household level by ordinary least square (OLS), where  $\Delta c$  refers to changes in household nondurable consumption<sup>71</sup>;  $time$  includes a full set of year dummies (1992~2002), which controls for all aggregate (uniform) effects, including seasonality, aggregate interest rates, and other macro variables which allow for changes in the households financial situation from year to year;  $Fisitx$  denotes the expectations of financial situation change; while  $W$  controls for demographic characteristics such as changes in the number of adults and children<sup>72</sup> in the household.

There are many possible sources of excess sensitivity, such as myopia and the existence of liquidity constraints. As a result, the second stage of the analysis is to explore the possible sources of excess sensitivity associated with the whole sample and with some sub-samples of it. The analysis also distinguishes between anticipated changes in financial situation that are negative (deteriorated financial situation changes) from those that are positive (improved financial situation changes). This asymmetry between negative and

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<sup>71</sup> Since many studies examine the change in log consumption, the results of the analysis using this alternative dependent variable are presented as well.

<sup>72</sup> Following Zeldes (1989), Dynan (1993), Lusardi (1996), and Souleles (1999), these variables help control for the most basic changes in household preferences over time. Expanding the variables in  $W$  would be possible to eliminate almost any excess sensitivity. Therefore  $W$  is restricted to the commonly used set of controls.

positive resource changes is first discussed in Altonji and Siow (1987) and recently analyzed by Shea (1995b;1995a). A simple extension of equation

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta Fisitx_{i,t} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.2),$$

following Shea (1995b), provides a deeper insight into the evolution of the consumption process given the following:

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta_1 Fisitx_{i,t}^- + \beta_2 Fisitx_{i,t}^+ + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.3)$$

where  $\beta_1$  and  $\beta_2$  are dummy variables indicating  $Fisitx_{i,t}^-$  and  $Fisitx_{i,t}^+$  respectively. This form allows us to test whether excess sensitivity can be explained by the following reasoned assumptions:

1. *Rule-of-Thumb Consumers.* There are consumers who are myopic. They are assumed to have a constant marginal propensity to consume out of current wealth or income and therefore do not behave as predicted by the REPIH. As a result, such consumers will be excessively sensitive to variables known in the information set. However, as mentioned in sub-section 2.2.3, rule-of-thumb consumers will respond to changes in their financial resources regardless of whether these are expected to be an improvement (a positive change) or a deterioration (a negative change). In other words, if consumers are myopic,  $\beta_1$  and  $\beta_2$  should both be significantly positive and of similar magnitudes.
2. *Liquidity Constraints.* Consumption models based on the presence of liquidity constraints predict a stronger (positive) response in consumption growth to positive predicted financial resource growth than to negative financial resource growth because liquidity constraints only preclude borrowing against future expected financial source growth, but do not inhibit saving ahead of future expected financial resource reductions. Hence consumers can save, and smooth their consumption when their financial resources are

expected to fall. This outcome would also be expected if forecast errors represent a transitory financial situation shock as in buffer-stock saving models, such behaviour reflects ‘self-imposed’ liquidity constraints. Thus, if liquidity constraints were the main cause for rejections of the REPIH, we should observe excess sensitivity only when consumers expect increases in financial resource, but are prohibited from borrowing. In such a case,  $\beta_2$  should be significant if a household head is genuinely liquidity constrained, but  $\beta_1$  should be insignificant.

3. *Asymmetric Preferences.* Another plausible explanation for the excess sensitivity to predicted changes in financial resource is that households do not have time-separable preferences as assumed. If there is inertia in preferences, perhaps due to the role of habit formation, households will only adjust their behaviour slowly. In the case of asymmetric preferences,  $\beta_1$  should be significant while  $\beta_2$  should be insignificant. Carroll (1995) applied two dummy variables to test the existence of an asymmetric response of consumption to positive and negative shocks to permanent income by using information on union contracts to construct a measure of expected income growth for each household. He found that the response of consumption to negative income shocks was much higher than those associated with positive income shocks. Likewise, Bowman *et al.* (1998) used a database derived from five countries (Canada, France, West Germany, Japan, and the United Kingdom) to estimate the expected income growth and found empirical support for an asymmetry in consumption behaviour. Bowman *et al.*'s method for estimating the expected income growth was to regress actual income growth at time  $t$  against the second through fourth lags of consumption growth, income growth, *ex post* real interest rates, and an error correction term formed from the second lag of the difference between consumption and income.

In sum, because the BHPS involves information on individuals' financial wellbeing, this chapter tests to see whether individuals' subjective financial wellbeing influences their consumption behaviour (non-durable consumption). Further, it examines the overall distribution of individual financial wellbeing and consumption, with respect to various categorizations of household types.

In the process of developing detailed simulation models I need to identify a proxy for non-durable consumption, while food and grocery expenditures are considered to be fairly unresponsive to changes in purchasing power in aggregate data, that is, the consumption of food is relatively inelastic to income, at the level of individual or household. We might expect to observe significant changes in food and grocery expenditure when there are noticeable changes in their financial circumstances, and a reasonably strong relationship between food expenditures and their financial wellbeing. All specifications have the same instrument sets for comparability. As a result, with the help of the micro data derived from the BHPS, I exploit cross-sectional variation by controlling for time effects and investigate the source of any excess sensitivity by using a random effects model.



## 6.3 RESULTS AND ANALYSIS

### 6.3.1 Evaluating Excess Sensitivity

In terms of the excess sensitivity tests, there are two main findings. First, the following Table 6.1 provides robust estimates of the model parameters for the estimating equation

$$\Delta c_{i,t+1} = \alpha \text{time}_{t+1} + \beta \text{Fisitx}_{i,t} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.2).$$

**Table 6.1 Excess Sensitivity Test**

Dependent Variable = Change in Nondurable Consumption (BHPS: 1991~2002)

Ind. Variable	Whole Sample		Male		Female		Married		Unmarried	
	Coef	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
Change Expectations	-0.1148**	-1.96	-0.0847	-1.33	-0.0446	-0.94	-0.0584	-0.70	-0.0585	-0.98
Age	-0.0733**	-4.48	-0.1247**	-7.39	-0.0259**	-2.55	-0.1475**	-4.61	0.0030	0.20
Age/Age/100	0.0883**	5.94	0.1289**	8.28	0.0300**	3.26	0.1613**	5.46	0.0084	0.64
Adult No. Change	1.3579**	10.97	1.2662**	9.56	1.0883**	11.20	0.9668**	5.44	1.9162**	15.85
Children No. Change	0.6440**	4.06	0.6762**	4.32	0.5879**	4.47	0.7103**	3.46	1.5401**	8.18
Constant	1.3644**	2.96	-36.4337**	-77.09	0.6872**	2.23	-40.5018**	-47.20	-0.3528	-0.86
Wald chi2(15)	106752.9		103831.3		41442.8		89434.74		45883.84	
R2	0.7427		0.7830		0.6946		0.8279		0.7118	
Number of Obs.	35495		27769		18026		17646		17849	

Ind. Variable	Employee		Self-employed		Higher		Secondary		Others	
	Coef	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
Change Expectations	-0.1096*	-1.79	-0.1441*	-1.86	-0.1605**	-2.16	0.0522	0.52	0.0339	0.10
Age	-0.0643**	-3.86	0.0233	1.07	-0.0032	-0.15	-0.1808**	-6.65	-0.0848	-0.93
Age/Age/100	0.0790**	5.23	0.0082	0.43	0.0307	1.59	0.1779**	6.65	0.0973	1.14
Adult No. Change	1.3412**	10.22	1.4836**	8.97	1.1939**	7.95	1.5559**	7.24	1.2357	1.47
Children No. Change	0.6946**	4.07	0.8849**	3.37	0.9221**	4.38	0.3875	1.59	1.1247	1.14
Constant	1.1867**	2.51	-1.3904**	-2.13	-0.5752	-0.90	4.0056**	5.63	1.5711	0.60
Wald chi2(15)	94818.27		50805.26		71613.4		35960.68		2551.19	
R2	0.7379		0.7135		0.7396		0.7667		0.7461	
Number of Obs.	32308		19577		23974		10637		884	

Note: Every equation contains full year dummies. Instruments are same for all estimated equations. The dependent variable is the change in weekly food and grocery consumption.

\*\* = significant at 5%, \* = significant at 10%.

Source: 1991 to 2002 yearly BHPS samples.

If the REPIH holds, one would expect to find that the coefficient of financial wellbeing growth,  $\beta$ , would not be statistically different from zero. Instead, the test reports a significant  $\beta$  with a coefficient estimate of -0.1148 for nondurable consumption in the whole sample. This clearly indicates that consumption fluctuated with anticipated changes in financial wellbeing, and this amounts to a decisive rejection of the REPIH: consumption is excessively sensitive to current financial wellbeing changes, or, in other words, it suggests that individuals fail to peg their consumption to expectation of their permanent wealth.

Carroll (2001) explains the correlation between future expected resource growth and the probability of excess sensitivity by arguing that such households are more likely to want to borrow, or because expected resource growth effectively raises the degree of impatience. In addition, the information on financial expectations appears to help predict consumption. The signs on  $\beta$  are negative in most sub-samples. Thus, in all cases, better financial states are associated with less steep consumption profiles - that is, higher expectations are associated with less saving. This outcome is both consistent with precautionary motives for saving (Deaton, 1992; Carroll, 1992; Lusardi, 1998) as well as with increases in expected future resources. While adding demographic variables into the consumption regression reduced the significance of the financial variable considerably, these variables act as important control variables. Thus age is employed as a significant variable in the regressions. Age decreased consumption up to 41.5, and thereafter increased it (because quadratic  $ax^2 + bx + c$  turns over at  $x = -b/2a$ , which for *age* and *age2* coefficient is  $(-(-0.0733)/2 \times 0.0883) \times 100 \approx 41.50$ ). Other demographic terms also showed plausible signs. For example, there was a positive relationship between consumption growth and family size, or change in the number of children.

Second, the evidence for excess sensitivity is statistically significant in only some sub-samples. For example, with respect to household heads who were

highly educated,  $\beta$  (-0.1605) was statistically significant at the 5% level; however it was insignificant for other groups in the education sub-sample. This suggests that highly-educated agents fail to smooth their consumption, but agents with comparatively lower education levels smooth consumption very effectively, in the sense that they do not display excess sensitivity. In the same vein, I can refer the employee, the self-employed, or higher degree holders as the excess sensitivity groups. Among the other groups, agents' expectations did not affect their nondurable consumption. In other words, the REPIH could not be rejected for results in these sub-groups.

### 6.3.2 Tests for Myopia and Liquidity Constraints

As was indicated earlier, deeper insights into the relationships between the excess sensitivity of consumption, and the dependence of consumption on financial situation change, can be obtained by extending equation

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta Fisitx_{i,t} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.2)$$

equation

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta_1 Fisitx_{i,t}^- + \beta_2 Fisitx_{i,t}^+ + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10)$$

(6.3). Changes in financial situation are divided into negative and positive parts to investigate whether consumption changes are more sensitive to stochastic financial deteriorations or improvements. The estimated equation and results are presented in the following Table 6.2.

**Table 6.2 Possible Sources of Excess Sensitivity**

Dependent Variable = Change in Nondurable Consumption (BHPS: 1991~2002)

Ind. Variable	Whole Sample		Male		Female		Married		Unmarried	
	Coef	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
<i>Deteriorated</i>	0.2395**	2.42	0.2572**	2.34	0.0540	0.68	0.1793	1.27	0.0999	1.03
<i>Improved</i>	-0.0124	-0.14	0.0446	0.48	-0.0372	-0.54	0.0376	0.31	-0.0229	-0.26
<i>Age</i>	-0.0725**	-4.43	-0.1236**	-7.32	-0.0258**	-2.54	-0.1468**	-4.59	0.0033	0.23
<i>AgeAge/100</i>	0.0882**	5.94	0.1287**	8.26	0.0300**	3.25	0.1611**	5.45	0.0083	0.63
<i>Adult No. Change</i>	1.3594**	10.98	1.2680**	9.57	1.0884**	11.20	0.9688**	5.45	1.9162**	15.85
<i>Children No. Change</i>	0.6402**	4.03	0.6706**	4.28	0.5877**	4.46	0.7037**	3.43	1.5404**	8.18
<i>Constant</i>	1.1265**	2.60	-36.7163**	-83.21	0.5911**	2.09	-40.6955**	-49.34	-23.9266**	-62.47

<i>Wald chi2(16)</i>	106758.8	103841.1	41440.7	89436.58	45882.09
<i>R2</i>	0.7427	0.7830	0.6946	0.8279	0.7118
<i>Number of Obs.</i>	35495	27769	18026	17646	17849

<i>Ind. Variable</i>	<i>Employee</i>		<i>Self-employed</i>		<i>Higher</i>		<i>Secondary</i>		<i>Others</i>	
	<i>Coef</i>	<i>T-Stat.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Coef.</i>	<i>T-Stat.</i>
<i>Deteriorated</i>	0.2665**	2.66	0.0332	0.29	0.1867*	1.64	0.1716	0.90	-0.4017	-0.56
<i>Improved</i>	0.0260	0.28	-0.2830**	-2.20	-0.1348	-1.19	0.1884	1.35	-0.1693	-0.34
<i>Age</i>	-0.0630**	-3.78	0.0221	1.01	-0.0030	-0.13	-0.1792**	-6.59	-0.0858	-0.94
<i>AgeAge/100</i>	0.0786**	5.21	0.0084	0.44	0.0306	1.58	0.1772**	6.62	0.0969	1.14
<i>Adult No. Change</i>	1.3438**	10.24	1.4839**	8.97	1.1943**	7.95	1.5564**	7.24	1.2270	1.46
<i>Children No. Change</i>	0.6892**	4.04	0.8862**	3.38	0.9213**	4.37	0.3807	1.56	1.2056	1.21
<i>Constant</i>	-33.1035**	-75.42	-1.5727**	-2.54	-0.9157	-1.53	3.9791**	5.91	-43.8725**	-17.51
<i>Wald chi2(16)</i>	94829.95		50809.74		71610.9		35965.68		2549.62	
<i>R2</i>	0.7379		0.7136		0.7396		0.7667		0.7462	
<i>Number of Obs.</i>	32308		19577		23974		10637		884	

Note: Every equation contains full year dummies. Instruments are same for all estimated equations. The dependent variable is the change in weekly food and grocery consumption.

\*\* = significant at 5%, \* = significant at 10%.

Source: 1991 to 2002 yearly BHPS samples.

A similar set of instruments as in the previous case were used for these estimates. These find that  $\beta_1$  in equation

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta_1 Fisitx_{i,t}^- + \beta_2 Fisitx_{i,t}^+ + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10)$$

(6.3) is strongly significant only when consumers expect deterioration in their future financial situation. Conversely, the coefficient of positive financial wellbeing growth is insignificant and ambiguous. The above exercise proves an important point in that we can formally reject  $\beta_1 = \beta_2 = 0$  in favour of  $\beta_1 > \beta_2$ , a result strikingly similar to that found by Shea (1995b).

Under predictable or expected financial wellbeing changes, myopia would imply that consumption fluctuates equally in response to both positive and negative financial situation variations. Thus, if households are indeed myopic,

they would be incapable of pegging their consumption to their permanent income, in which case, consumption should increase whenever their financial situation improves, and decrease whenever their financial situation deteriorates. Hence, changes in consumption should be uniformly related to changes in financial wellbeing. This analysis finds that consumption is affected only by negative financial wellbeing growth. This does not conform to the situation of myopic consumption behaviour. On the other hand, if liquidity constraints exist, predicted financial situation deterioration should make forward-looking individuals save more, and thereby avoid a decline in their consumption. Therefore, consumption should be more sensitive to predicted financial situation improvement than to financial situation deterioration, due to the existence of anticipatory savings. However, if financial wellbeing fluctuations are predictable, the above results are not indicative of either myopia or liquidity constraints. And, the effect of anticipated financial wellbeing fluctuations might be quite different. Individuals, then, would be incapable of forecasting financial situation deterioration. Thus, it is plausible that an inability to borrow pulls consumption down, with the deteriorated financial situation. Nevertheless, the failure of the REPIH is apparent from the empirical results. However, the cause for this breakdown remains unclear in the present analysis.

Consequently, asymmetric preferences appear to be the most important source of the excess sensitivity found in this study. There are many ways to model time nonseparabilities in preferences, and I would focus on those that induce asymmetric responses to positive and negative predicted financial resource changes. Such behaviour could arise if individuals weigh outcomes that are above and below a certainty equivalent, or treat gains and losses differently.<sup>73</sup> For example, if consumers with asymmetric preferences (i.e., they are averse to negative changes) expect a negative income change in  $t+1$ , they would gamble that the negative shock will not occur, rather than revise

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<sup>73</sup> Examples include “loss aversion” proposed by Tversky and Kahneman (1991) and extended by Bowman, Minehart, and Rabin (1993) into a saving model; “disappointment aversion” axiomatized by Gul (1991) and used to explain the so-called Allais paradox.

$c_t$  downward in expectation of the negative shock. A small reduction in  $c_t$  and a large negative change in  $c_{t+1}$  can therefore translate into a large negative  $\Delta c_{t+1}$  for a given expected change in financial resources. In contrast, when consumers anticipate a future but positive income change in period  $t$ , they will revise  $c_t$  upward immediately just as any expected utility maximizer would. This implies that  $\Delta c_{t+1}$  will be small in response to the anticipated positive change in financial resources. In summary, I used equation  $\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta_1 Fisitx_{i,t}^- + \beta_2 Fisitx_{i,t}^+ + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10)$  (6.3) to test three hypotheses and found that *Asymmetric Preferences* appears to be the most important source of excess sensitivity.

Turning to the results from sub-samples, the coefficients of anticipated financial wellbeing deterioration are significant in the male, employee, and the highly-educated groups, in line with the explanation of asymmetric preferences in the whole sample. However, the coefficient of financial wellbeing improvement is significant in the self-employed group. This result implies that liquidity constraints can be the source of excess sensitivity for the self-employed respondents.

## 6.4 CONCLUSION

This chapter has presented a comprehensive discussion on the implications of the REPIH and has evaluated the model empirically with a household micro panel data set which includes exhaustive information on consumption. The theoretical formulation presented here is that of a benchmark consumption model following the main assumptions of the REPIH. The primary focus of the discussion was to re-evaluate the excess sensitivity puzzle of consumption behaviour. Simple investigations on the BHPS data set, used for empirical aspects of this thesis, revealed some interesting facts. What follows from this empirical work is that consumption may be associated with variables other than financial wealth. In the introductory sections, I reviewed the work by Souleles (2001) and Flavin (1981) which used US data sets. Their studies appear to be an excellent benchmark for formulating the analysis strategy: this empirically revisits the random-walk hypothesis of consumption using Souleles's method; used the extensions presented in Shea (1995b) to evaluate myopic consumption behaviour and the existence of liquidity constraints; and finally, a follow-up of the Flavin test of excess sensitivity was carried out to investigate the role of expectation errors in explaining the excess sensitivity. While this previous work used aggregate data to test the REPIH hypothesis, the present study employed their methodology to investigate patterns from the BHPS data set in the micro level.

The results clearly refute the predictions of the rational expectation extensions of the REPIH. In the first regression (Table 6.1), the results indicate an excess sensitivity of current consumption to one-period lagged financial wellbeing. Higher financial expectations were correlated with less saving in the whole sample. Age decreases consumption up to 41.5, and thereafter increases it. The coefficients of family size and change in number of children are significant and positive.

However, although the failure of the REPIH is substantiated from these results, they do not shed light on whether it is myopia or liquidity constraints that are the main cause for this failure. Ambiguity arises because if myopia

exists, then consumption should fluctuate with both financial wealth improvements and deteriorations. If liquidity constraints exist, and financial situation changes are predictable, individuals should be able to smooth their consumption in cases of declines in financial wealth by saving beforehand, in forecast of the future financial deterioration. If financial deterioration cannot be forecasted, anticipatory saving is not plausible. In the presence of strict borrowing constraints, households might face a fall in their consumption in such circumstances. In the second step, financial wealth growth was divided into positive and negative parts. The results in the whole sample indicate that consumption fluctuations are significantly related to financial wealth declines, but not related to financial wealth increases. This wiped out both myopic and liquidity constraints and makes asymmetric preferences to be the most possible source of excess sensitivity in this empirical analysis. Further, given the significance of the cross-sectional distribution of expectations, the failure of the REPIH in the male, the highly educated, and employee sub-groups, was due to asymmetric preference. Meanwhile, the rejection of the REPIH in the self-employed sub-group was caused by liquidity constraints.



## Chapter 7

# SYSTEMATIC HETEROGENEITY IN EXPECTATION ERRORS

### 7.1 INTRODUCTION

In most cases, economists who assume that individuals do not make systematic errors under the REPIH find that it works well using aggregate data. However, this is especially likely to be a problem in our empirical micro-level analysis since both the financial situation variables and expectation errors were found to be correlated with household's demographic characteristics in Chapter 5. These findings suggest that even a long sample period and a full set of time dummies might not be enough to ensure the orthogonality of the expectation errors with the financial situation variables<sup>74</sup>. Consequently, another possibility to explain the failure of the REPIH, but one that has not previously received much scrutiny in the literature is systematic heterogeneity in *expectation errors*. The greatest research potential for this possibility will be the extent to which we can incorporate the large amount of heterogeneity in the population into our empirical analysis. If consumption decisions are influenced by respondents' financial situation expectations, then consumption changes will depend upon the perceived financial situation changes. The extent to which subjective financial situation expectations influence household decisions can be understood by analysing the relationship between consumption changes and expectation errors.

This chapter applied Flavin (1981)'s model to identify the consumers' reaction to expectation errors and changes in expectations of their future resources.

Melvin (2003) also examined the link between subjective job loss expectations and the subsequent impact on household consumption behaviour behind the

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<sup>74</sup> Souleles (2001) tests this hypothesis and argues that expectation errors might not be classical, but rather contain systematic component correlated with the excess sensitivity regressor.

intuition suggested by Flavin (1981) and Campbell and Deaton (1989). The direct measures of households' expectation errors found in the BHPS make it possible to explore whether expectation errors play an important role in the rejection of the REPIH. As a result, the expectation errors were added into equation  $\Delta c_{i,t+1} = \alpha time_{t+1} + \beta Fisitx_{i,t} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (6.2)$

and equation

$$\Delta c_{i,t+1} = \alpha time_{t+1} + \beta Fisitx_t + \phi Fisite_{i,t+1} + \phi \Delta Fisitx_{i,t+1} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10)$$

(7.11) was used to consider whether systematic heterogeneity in expectation errors was another source of excess sensitivity.

## 7.2 RELATED STUDIES

Flavin (1981) used the excess sensitivity tests to mount a powerful rejection of the REPIH. Two ideas are developed in her work. One is that a stronger test for consumption than the reduced-form equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10) is provided. In addition, she attempts to identify consumer's reaction to both anticipated and unanticipated income shocks. Flavin's model mainly focuses on the role played by current income in providing new information about future income. Under the permanent income hypothesis a rational agent can use such information to upgrade his/her permanent income expectations. A drawback of Flavin's test is that both income and consumption processes need to be modelled, and the results which emerge from this are sensitive to the modelling specifications that are used<sup>75</sup>.

Thus, a trended ARMA representation was used to model the time-series properties of the income process and to specify agent's expectations about their future levels of income. Under assumption of an ARMA process for income, actual revisions in permanent income can possibly be acquired from the contemporaneous observation of current income. This revision is given by the forecast error in the ARMA specification, and such an error represents unanticipated news associated with current observations of income<sup>76</sup>. The magnitude of the revision would then depend on the parameters of the ARMA representation of the income process. Together with this argument, one can 'specify a structural equation relating the change in consumption to the contemporaneous revision in permanent income (modelled using the income innovation) and the change in current income'. [pp.976]. As a result, it

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<sup>75</sup> See Deaton (1992) chapter 3

<sup>76</sup> Flavin also suggests that the error in the ARMA representation for income can represent, for econometricians attempting to model consumption, not just the 'true innovation' in income, but also the predictive 'value of all the lagged values of variables observed by the individual, but not explicitly incorporated in the regression.' [pp. 991]. This is an issue related to Campbell's (1987) and West's (1988) superior information.

is possible to use Flavin's model to explore the determinants of change in consumption for inferring agents' expectations.

Since the path of future income is uncertain, an individual must make his consumption plans on the basis of some set of expectations about future income. Given the expectations about future income held in period  $t$ , the individual's permanent income can be expressed as

$$y_t^p = r \left[ A_t + \sum_{k=0}^{\infty} \left( \frac{1}{1+r} \right)^{k+1} E_t y_{t+k} \right] \quad (7.1)$$

where  $y_t^p$  is permanent income at time  $t$ ,  $A_t$  is their stock of assets at time  $t$ ,  $r$  is the constant real rate of interest,  $y_t$  is their labour income at time  $t$ , and  $E_t$  is the expectations operator for expectations at time  $t$ .

Allowing for a stochastic, or transitory, component of consumption, the consumption function for the representative individual becomes  $c_t = y_t^p + u_t$ , or

$$c_t = r \left[ A_t + \sum_{k=0}^{\infty} \left( \frac{1}{1+r} \right)^{k+1} E_t y_{t+k} \right] + u_t \quad (7.2)$$

where the error term  $u_t$  denotes the transitory component of consumption.

Solving for  $c_{t+1}$  in terms of  $c_t$ , subject to  $A_{t+1} = (1+r)A_t + y_t - c_t$ , gives:

$$c_{t+1} = c_t + r \sum_{k=0}^{\infty} \left( \frac{1}{1+r} \right)^{k+1} (E_{t+1} - E_t) y_{t+k+1} - (1+r)u_t + u_{t+1} \quad (7.3)$$

Consumption will evolve as random-walks only if the transitory consumption term is identically zero,  $u_t \equiv 0$ . So I can re-write

$$\begin{aligned}
\Delta c_{t+1} &= r \sum_{k=1}^{\infty} (1+r)^{-k} (E_{t+1} - E_t) y_{t+k} \\
&= r \left[ \left( \frac{1}{1+r} \right) (y_{t+1} - E_t y_{t+1}) + \sum_{k=2}^{\infty} \left( \frac{1}{1+r} \right)^{-k} (E_{t+1} - E_t) y_{t+k} \right] \quad (7.4)
\end{aligned}$$

Consequently, I use the above equation to understand how changes in expectations of future income relate to consumption changes. Because the first term represents the household's expectation errors concerning current income,  $y_{t+1}$ , while the second term corresponds to the influence of changing expectations regarding future income  $y_{t+k}$ ,  $k \geq 2$ , changes in consumption between the two periods can be decomposed into these two terms. A basic empirical implication of this model is that, even if the behavioural marginal propensity to consume out of current income is zero, consumption should respond to changes in current income because these innovations provide new information about future income, and therefore induce revisions in expected permanent income. In other words, one alternative hypothesis is that expectation errors might not be classical, but rather contain systematic components correlated with the excess sensitivity regressor. Chamberlain (1984) states that systematic expectation errors can be a potential problem in estimating any rational expectations (or forward-looking) model in a short panel. For instance, female respondents might, on average, have been optimistic about the future over the sample period, so that they increase their consumption, due to their over-optimism, or a positive correlation between consumption and expectations would not be inconsistent with the REPIH. The availability of the direct measures of respondents' expectation errors in the BHPS makes it possible to test this point directly.

The null hypothesis in Flavin's paper is the permanent income hypothesis, in the form of equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10), associated with an autoregressive specification for the process governing labour income. In general, it also can be specified as followed:

$$\Delta c_t = \varepsilon_t = \alpha \eta_t = \alpha \sum_{k=0}^{T-t} (1+r)^{-k} (E_t - E_{t-1})(w_{t+k} + y_{t+k}^r) \quad (7.5)$$

$$\phi(L)y_t = \varepsilon_t \quad (7.6)$$

where  $y_{t+k} = w_{t+k} + y_{t+k}^r$ . Flavin also introduces the possibility of unanticipated capital gains in the model, so surprises in non-labour income,  $y^r$ , are allowed to be different from zero. Strictly speaking, Flavin's excess sensitivity hypothesis is a substantial generalization of equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t$  (2.10)<sup>77</sup> and allows consumption to respond to current and lagged changes in income by more or less than is required by the permanent income theory. The extended version of Flavin's model is as follows:

$$\xi(L)y_t = \mu + \varepsilon_t \quad (7.7)$$

$$\Delta c_t = \gamma + \theta \varepsilon_t + \beta(L)\Delta y_t + u_t \quad (7.8)$$

where  $\xi(L) = \sum_{i=0}^p \xi_i L^i$ ,  $\xi_0 = 1$  and  $\beta(L) = \sum_{i=0}^p \beta_i L^i$ ;  $\beta_0 \neq 1$ . It should be noted that Flavin rearranges the  $AR(p)$  income process equation and substitutes the error term  $\varepsilon_t$  into the consumption equation for income variable. Hence, the first difference of consumption responds both to current and lagged changes in income as well as the innovation in the income process in the unrestricted version of the model. The measures of excess sensitivity of consumption to current income,  $\beta$ , provide an estimate of the amount of additional response of consumption to the new information contained in current income. In sum, according to the REPIH, consumption changes should not be related to other variables, except for the amount of income

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<sup>77</sup> In her 1993 paper, Flavin argues that 'the consumption data is generated by the excess sensitivity model' [pp. 665]

innovation provided by the error term  $\varepsilon$ . Hence, all the  $\beta$  coefficients, which represent the extent to which consumption responds to previously predictable changes in income, should be zero.

In Flavin's paper, she runs an eight-order auto-regression ( $p=8$ ) for the labour income process. The restriction  $\beta_0 = \beta_1 = \dots = \beta_7 = 0$  is imposed on the system to obtain a constrained system that can be estimated. She then used data on non-durable goods consumption from 1949(3) to 1979(1) and found that the likelihood ratio statistic for the hypothesis  $\beta_0 = \beta_1 = \dots = \beta_7 = 0$  was 27.02 for  $\chi^2(8) = 21.96$ . Hence, the random-walk specification of Hall was rejected by Flavin. [pp. 999]. The estimates for the first three sensitivity parameters are .335, .071 and .049. These results indicate a strong excess sensitivity response of consumption to changes in current income. [pp. 1002]

However Mankiw and Shapiro (1985) and Deaton (1992) began to question the validity of the stationary income process assumption, one of the main econometric techniques used by Flavin, and discussed the actual form that modelling the income process should take when such a process appears to be non-stationary. They also criticized the method used by Flavin to account for the upward trending behaviour of income which dealt with the non-stationary nature of the income process by fitting exponential time-trends to both consumption and income, and by replacing consumption and income in the regressions by their residuals. In particular, Mankiw and Shapiro argued that excess sensitivity is induced by this detrending procedure, even if excess sensitivity is not present in the data. Basically,  $y$  is a non-stationary variable while  $\Delta c$  is stationary, so running a system like  $\xi(L)y_t = \mu + \varepsilon_t$  (7.7) cannot provide much information for both sides of the consumption equation, as each are of a different order of integration<sup>78</sup>. The problems about making inferences about the coefficients on lagged income using standard  $t$  and  $F$ -tests are essentially the same as the problems that occur in discerning

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<sup>78</sup> To see this note that in (21) the income equation is already in reduced form, and to obtain the reduced form for consumption I only need to substitute the income equation into the consumption equation (see Deaton (1992) pp. 89).

the existence of a unit root in a univariate time series, and the use of standard normal tables at usual significance levels results in over-rejection. Deaton (1992) ran a Monte Carlo experiment<sup>79</sup> to test this point and found that the  $t$ -statistics for excess sensitivity on each of the income variables, and the test for excess sensitivity as a whole (an  $F$ -test), rejected more than the customary 5%<sup>80</sup>.

However Stock and West (1988) challenged Mankiw and Shapiro's suggestion that excess sensitivity was the result of bad econometric practice by using the concepts of cointegration and error correction to provide a means of testing excess sensitivity:

$$c_t = b_0 + b_1 c_{t-1} + b_2 y_{t-1}^d + b_3 y_{t-2}^d + u_t \quad (7.9)$$

where  $y^d$  is the same income measure used by Flavin. Now, if savings is defined as

$$c_t = b_0 + (b_1 + b_3) c_{t-1} + (b_2 - b_3) y_{t-1}^d + b_3 s_{t-1} + u_t \quad (7.10)$$

We would see that the savings variable plays the error correction role in this model if we expect the coefficient of the lagged consumption variable  $(b_1 + b_3)$  to be close to one. Sims, Stock and Watson (1990) show that in a regression of integrated variables of the same order, standard asymptotic theory can be applied to parameters that can be written as the coefficients of stationary variables. If consumption and disposable income are cointegrated, then the last two variables of equation  $c_t = b_0 + (b_1 + b_3) c_{t-1} + (b_2 - b_3) y_{t-1}^d + b_3 s_{t-1} + u_t$  (7.10) are stationary. Hence, it is possible to make inferences about the excess sensitivity parameters  $b_2$  and  $b_3$ . Stock and West also used the Monte Carlo method in

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<sup>79</sup> Deaton himself recognizes that 'the Monte Carlo results, although tailored to reflect the actual data, do not generate results that look like Flavin's'. [pp. 94]

<sup>80</sup> The overall  $F$ -test rejects 43% of the time, and the  $t$ -test for  $\beta_0$  and  $\beta_1$  rejects 14% and 21% of the time respectively rather than the correct 5% [pp. 93].



experiments to show that their technique worked and found evidence in favour of excess sensitivity. Thus, according to Stock and West, the problem with Flavin's test procedure is that the imposition of a unit coefficient upon the lagged consumption variable alters the asymptotic distributions of the estimates. However once I correct for this problem, evidence for excess sensitivity still appears to exist.

### 7.3 METHODOLOGY

To carry out a further investigation of the failure of Hall's random-walk hypothesis, this chapter returns to equation  $c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow$

$$\Delta c_t = \alpha + \beta Q_t + \varepsilon_t \quad (2.10) \text{ in chapter 2. The residual, } \varepsilon, \text{ in Equation } c_t = \lambda c_{t-1} + \varepsilon_t \rightarrow \Delta c_t = \alpha + \beta Q_t + \varepsilon_t \quad (2.10) \text{ determines changes in}$$

consumption and potentially includes many factors, such as measurement error or unobserved heterogeneity in discount rates. According to Flavin (1981), Campbell and Deaton (1989), and Melvin (2003), equation

$$\Delta c_t = \varepsilon_t = \alpha \eta_t = \alpha \sum_{k=0}^{T-t} (1+r)^{-k} (E_t - E_{t-1})(w_{t+k} + y_{t+k}^r) \quad (7.5) \text{ can help}$$

to decompose  $\varepsilon$  into two components: the change in consumption resulting from unexpected current financial changes; and any revisions in expected future financial situations. Empirically, the following equation

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta Fisitx_t + \phi Fisite_{i,t+1} + \phi \Delta Fisitx_{i,t+1} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10)$$

(7.11) is used, which shows a direct relationship between financial expectation errors and household consumption, to assess whether systematic heterogeneity in expectation errors can lead to spurious inference more generally in forward-looking models.

$$\Delta c_{i,t+1} = \alpha time_{i,t+1} + \beta Fisitx_t + \phi Fisite_{i,t+1} + \phi \Delta Fisitx_{i,t+1} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \quad (7.11)$$

Where  $Fisite$  denotes financial expectation errors and  $\Delta Fisitx$  denotes changes in respondents' financial expectations. For consistent estimates of  $\beta$ , the forecast errors need to be uncorrelated with the excess sensitivity regressor  $Fisitx$ . With direct measures of expectation errors, we can test the implications of systematic heterogeneity in the errors. Also, shocks to the financial situation are considered to be among the most important sources of the overall changes in consumption in  $\varepsilon$ . Under the alternative hypothesis that excess sensitivity is generated by demographic components in expectation errors, we would expect to find  $\beta = 0$  and  $\phi > 0$ , since the REPIH allows for consumption to respond to the current financial shocks represented by  $Fisite$ .  $\varepsilon_{i,t} = \mu_i + v_{i,t}$ , where  $\mu_i$  captures the unobserved, time-invariant characteristics of the individual. It means that, for all observations relating to a given individual,  $\mu_i$  will have the same value, reflecting their unchanging unobserved characteristics. For  $\mu_i$  to be properly specified, it must be orthogonal to the individual effects.  $v_{it}$  are random errors. In this case  $\mu_i \sim IID(0, \sigma_\mu^2)$ ,  $v_{it} \sim IID(0, \sigma_v^2)$  and the  $\mu_i$  are independent of the  $v_{it}$ . In other words, the cross-sectional specific error term  $\mu_i$  must be uncorrelated with the errors of the variables if this is to be modelled with other explained variables. However the later assumption is unrealistic in the present context, as  $W$  includes demographical variables that are correlated with, for example, any unobserved ability captured in  $\mu_i$ . Furthermore, if this unobserved individual specific effect is also correlated with the expectation errors, then the main coefficient of interest,  $\beta$ , will be biased. Panel data allow us to overcome these potential problems of endogeneity by treating the unobserved effect  $\mu_i$  as random, and I estimate equations

$$\Delta c_{i,t+1} = \alpha time_{t+1} + \beta Fisitx_t + \phi Fisite_{i,t+1} + \phi \Delta Fisitx_{i,t+1} + \gamma W_{i,t+1} + \varepsilon_{i,t+1}$$

$$(t = 1, \dots, 10)$$

(7.11) using random effect models.

## 7.4 RESULTS AND ANALYSIS

There is likely to be a multicollinearity problem if financial expectations changes are correlated with expectation errors. In other words, even a long sample period and a full set of time dummies might not be enough to ensure orthogonality of the expectation errors with the financial expectations regressors. To test for multicollinearity each  $x$  was regressed on all of the other  $x$  variables. The  $1 - R^2$  from this regression was then used to see what fraction of the first  $x$  variable's variance was independent of the other  $x$  variables. The results from VIF (Variance Inflation Factor) in Table 7.1 give a quick and straightforward check for multicollinearity.

**Table 7.1 Variance Inflation Factor (VIF)**

<i>Variable</i>	<i>VIF</i>	<i>1/VIF</i>
<i>Age</i>	46.16	0.021665
<i>Age2</i>	45.27	0.022089
<i>Financial Expectations</i>	2	0.499809
<i>Expectation errors</i>	1.41	0.707325
<i>Expectations Change</i>	1.6	0.626314
<i>Children No. Change</i>	1.03	0.973695
<i>Adult No. Change</i>	1	0.99537
<i>Mean VIF</i>	14.07	

Source: Data derived from the BHPS (1991~2002)

The  $1/VIF$  column at right in a VIF table gives the values equal to  $1 - R^2$ . It shows that 70.7% of the variance in *expectation errors* was independent of *age*, *age2*, *financial expectations*, *expectations change*, *change in number of adults*, and *change in number of children*. Similarly, about 62.6% of the variance in *expectations change* was independent of the other variables.

The VIF column in the centre of the VIF table reflects the degree to which other coefficients' variances (and standard errors) are increased due to the

inclusion of that predictor. This shows that both *expectation errors* and *expectations change* have virtually no impact on the other variances. In sum, there is no substantial multicollinearity in the regressions.

**Table 7.2** shows that the coefficients of  $\varphi$  on the expectation errors, *Fisite*, are significant in the whole sample and nearly all of the sub-samples, despite the inclusion of the time dummies in the equation.

**Table 7.2 Systematic Heterogeneity in Expectation Errors**

Dependent Variable = Change in Nondurable Consumption (BHPS: 1991~2002)

Ind. Variable	Whole Sample		Male		Female		Married		Unmarried	
	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
<i>Expectations</i>	0.0916	1.06	0.0734	0.81	0.0340	0.52	0.0528	0.42	-0.0473	-0.54
<i>Expectation errors</i>	0.2712**	5.37	0.2008**	3.68	0.2098**	5.33	0.2292**	3.17	0.2319**	4.71
<i>Expectations Change</i>	0.0094	0.15	-0.0066	-0.10	-0.0787	-1.58	-0.0875	-1.01	-0.1799**	-2.88
<i>Age</i>	-0.0688**	-4.32	-0.1175**	-7.14	-0.0257**	-2.70	-0.1381**	-4.39	0.0055	0.38
<i>AgeAge/100</i>	0.0833**	5.77	0.1219**	8.04	0.0292**	3.39	0.1502**	5.17	0.0043	0.33
<i>Adult No. Change</i>	1.4008**	11.11	1.3121**	9.72	1.0882**	11.17	1.0018**	5.55	1.9183**	15.64
<i>Children No. Change</i>	0.7338**	4.57	0.7849**	4.96	0.6148**	4.67	0.8679**	4.19	1.5349**	8.07
<i>Constant</i>	-34.0602**	-71.05	-36.8576**	-74.61	-22.962**	-71.00	2.6456**	2.94	-0.3036	-0.68
<i>Wald chi2(17)</i>	101508.8		99034.24		39406.5		85128.34		44158.11	
<i>R2</i>	0.7431		0.7836		0.6954		0.8278		0.7155	
<i>Number of Obs.</i>	33842		26519		17159		16878		16964	

Ind. Variable	Employee		Self-employed		Higher		Secondary		Others	
	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
<i>Expectations</i>	0.0274	0.30	0.2884**	2.51	0.0772	0.70	0.3247**	2.31	-0.3071	-0.61
<i>Expectation errors</i>	0.1973**	3.79	0.2801**	4.07	0.2559**	4.04	0.3063**	3.65	0.0423	0.14
<i>Expectations Change</i>	-0.0103	-0.16	0.2538**	3.01	0.0593	0.76	0.0585	0.57	-0.6300*	-1.72
<i>Age</i>	-0.0560**	-3.35	0.0332	1.55	-0.0014	-0.07	-0.1785**	-6.59	-0.0793	-0.86
<i>AgeAge/100</i>	0.0704**	4.65	-0.0013	-0.07	0.0274	1.48	0.1767**	6.63	0.0872	1.01
<i>Adult No. Change</i>	1.3433**	10.06	1.6320**	9.58	1.2940**	8.50	1.5325**	6.95	1.1838	1.40
<i>Children No. Change</i>	0.7061**	4.10	1.1414**	4.29	1.0624**	5.04	0.4047	1.62	1.4404	1.40
<i>Constant</i>	-33.1386**	65.96	-2.4334**	-3.55	-0.9631	-1.46	-36.362**	-48.38	2.3245	0.82
<i>Wald chi2(17)</i>	90390.05		48296.51		67982.0		34669.7		2559.19	
<i>R2</i>	0.7380		0.7157		0.7419		0.7659		0.7502	
<i>Number of Obs.</i>	30827		18515		22649		10323		870	

Note: Every equation contains full year dummies. Instruments are same for all estimated equations. The dependent variable is the change in weekly food and grocery consumption.

\*\* = significant at 5%, \* = significant at 10%.

Sources: 1991 to 2002 yearly BHPS samples.

It notes that the excess sensitivity regressor  $\beta$  becomes insignificant in all groups, except for the self-employed and the respondents with secondary education level, when expectation errors and expectations changes are controlled for. This means that some excess sensitivity persists among self-employed and the secondary-educated respondents and is not due to heterogeneity in expectation errors alone. However, for most respondents, some of the excess sensitivity appears to be due to systematic heterogeneity in expectation errors. This suggests the possibility that previous excess sensitivity tests might have made spurious inferences. Also, the resulting coefficients of expectation errors in **Table 7.2** are positive and marginally significant. In other words, the more positive the expectation errors, the more pessimistic the household is in regards to their financial situations and the larger is the magnitude by which they would change their consumption. The coefficients  $\phi$  of the changes in expectations of future financial resources are not significant except for the unmarried and the self-employed groups. The insignificance of the  $\phi$  coefficients is consistent with the assumption that changes in expectations of future financial resources are incorporated into current consumption.

For more details about the response of consumption to expectation errors, I distinguished between expectation errors that were positive (under-estimated/pessimistic) from those that were negative (over-estimated/optimistic), and denoted them by  $Fisite_{i,t+1}^+$  and  $Fisite_{i,t+1}^-$ , respectively. The equation now took the form:

$$\begin{aligned} \Delta c_{i,t+1} = & \alpha time_{i,t+1} + \beta Fisitx_t + \phi_1 Fisite_{i,t+1}^- + \phi_2 Fisite_{i,t+1}^+ \\ & + \phi \Delta Fisitx_{i,t+1} + \gamma W_{i,t+1} + \varepsilon_{i,t+1} \quad (t = 1, \dots, 10) \end{aligned} \quad (7.12)$$

**Table 7.3 Asymmetric Preference in Expectation Errors**

Dependent Variable = Change in Nondurable Consumption (BHPS: 1991~2002)

Ind. Variable	Whole Sample		Male		Female		Married		Unmarried	
	Coef	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
<i>Expectations</i>	0.0490	0.58	0.0385	0.43	0.0081	0.13	0.0180	0.15	-0.0727	-0.85
<i>Over-estimated</i>	-0.4081**	-4.87	-0.3243**	-3.58	-0.2862**	-4.38	-0.4059**	-3.41	-0.4083**	-4.99
<i>Under-estimated</i>	0.1088	1.17	0.0384	0.38	0.1571**	2.19	0.0079	0.06	0.0881	0.99
<i>Expectations Change</i>	0.0196	0.31	0.0028	0.04	-0.0768	-1.54	-0.0764	-0.88	-0.1743**	-2.78
<i>Age</i>	-0.0694**	-4.36	-0.1178**	-7.16	-0.0259**	-2.72	-0.1386**	-4.40	0.0053	0.37
<i>Age/Age/100</i>	0.0833**	5.77	0.1216**	8.01	0.0291**	3.38	0.1498**	5.15	0.0039	0.30
<i>Adult No. Change</i>	1.4039**	11.14	1.3132**	9.73	1.0935**	11.23	1.0049**	5.56	1.9179**	15.64
<i>Children No. Change</i>	0.7322**	4.56	0.7836**	4.96	0.6162**	4.68	0.8642**	4.17	1.5370**	8.08
<i>Constant</i>	1.0745**	2.21	-36.7064**	-74.23	-22.872**	-70.55	2.8337**	3.15	-23.5913**	-53.00
<i>Wald chi2(18)</i>	101498.2		99029.68		39400.4		85136.12		44176.01	
<i>R2</i>	0.7431		0.7836		0.6954		0.8278		0.7155	
<i>Number of Obs.</i>	33842		26519		17159		16878		16964	

Ind. Variable	Employee		Self-unemployed		Higher		Secondary		Others	
	Coef	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.	Coef.	T-Stat.
<i>Expectations</i>	-0.0035	-0.04	0.2462**	2.18	0.0421	0.39	0.2701**	1.96	-0.2683	-0.54
<i>Over-estimated</i>	-0.3178**	-3.68	-0.4010**	-3.66	-0.3588**	-3.49	-0.5398**	-3.76	-0.0316	-0.06
<i>Under-estimated</i>	0.0544	0.58	0.0794	0.68	0.1205	1.09	0.0748	0.44	0.2042	0.33
<i>Expectations Change</i>	-0.0019	-0.03	0.2707**	3.20	0.0719	0.92	0.0634	0.61	-0.6364*	-1.74
<i>Age</i>	-0.0566**	-3.38	0.0329	1.53	-0.0020	-0.10	-0.1781**	-6.57	-0.0800	-0.86
<i>Age/Age/100</i>	0.0704**	4.65	-0.0012	-0.07	0.0275	1.49	0.1753**	6.57	0.0887	1.02
<i>Adult No. Change</i>	1.3439**	10.06	1.6354**	9.60	1.2956**	8.51	1.5380**	6.97	1.1840	1.40
<i>Children No. Change</i>	0.7045**	4.09	1.1504**	4.33	1.0608**	5.03	0.4004	1.60	1.4624	1.42
<i>Constant</i>	0.9124*	1.80	-32.6397**	-47.91	-33.678**	-52.17	-36.132**	-47.95	2.3397	0.82
<i>Wald chi2(18)</i>	90387.81		48285.78		67970.9		34675.5		2556.6	
<i>R2</i>	0.7380		0.7156		0.7419		0.7659		0.7503	
<i>Number of Obs.</i>	30827		18515		22649		10323		870	

Note: Every equation contains full year dummies. Instruments are same for all estimated equations. The dependent variable is the change in weekly food and grocery consumption.

\*\* = significant at 5%, \* = significant at 10%.

Sources: 1991 to 2002 yearly BHPS samples.

Table 7.3 shows that the results of splitting the expectations error term were again consistent with the predicted result: positive expectation errors were positively correlated with consumption but the relationship was insignificant except for women. In addition, there were no significant difference in the consumption growth changes between over-pessimistic agents and “smart”

agents. This implies that agents refuse to decrease their consumption level in  $c_t$  when they are pessimistic about their future financial source.  $\Delta c_{t+1}$  will be small when their pessimistic expectations are proved to wrong. In contrast, the coefficient for negative expectation errors (over-estimated) are also of the correct sign and highly significant in all of the sub-groups. Thus consumers who tend to be optimistic increase their consumption more than those that have correct expectations of their future financial resources. It means that agents increase their consumption as soon as they feel optimistic about their future financial resources. But, if they are over-estimated, there would be a large increase in  $c_t$  and a relatively lower increase, or even a reduction, in  $c_{t+1}$ . This would lead to negative consumption growth. So, the results of splitting the expectation errors provide more evidence to support the finding that asymmetric preferences are an important cause of excess sensitivity.

## 7.5 CONCLUSION

In this chapter, we use the finding from a direct test of the rationality of expectations made in Chapter 5 to look into household or individual systematic expectation errors and relate them to the understanding of excess sensitivity puzzles found in Chapter 6. This chapter tried to remove the ambiguity in understanding the cause for the breakdown of the REPIH by considering whether the systematic heterogeneity in forecast errors explains this failure. Previous studies, which lacked explicit measures of these errors, have not been able to consider this hypothesis directly. The results in this chapter present that demographic components of forecast errors were found to explain some of the excess sensitivity. Excess sensitivity in most of sub-groups was due to systematic heterogeneity in expectation errors alone with except of the self-employed and the secondary-educated. The pessimistic agents had more fluctuated consumption profile. Generally speaking, since forecast errors are correlated with household demographic characteristics, they will be correlated with many regressors of interest in forward-looking models, suggesting that non-classical forecast errors are in practice a general and potentially serious problem. In addition, the asymmetric responses of expectation errors to consumption are consistent with another alternative model of behaviour: that of individuals exhibiting loss aversion over future consumption changes.



## *Chapter 8*

# **SUMMARY AND CONCLUSIONS**

Benchmark models of optimization, in the spirit of the Permanent Income Hypothesis, present a strong theoretical case for a smooth consumption regime in which households do not allow their consumption to fluctuate with anticipated variations in their income. Hall's (1982) extension of the PILCH served as an important breakthrough in testing the implications of the benchmark model. His exposition clearly established that consumption should follow a random-walk pattern apart from a trend, with the lagged values of variables having no role to play in predicting present consumption. However, numerous subsequent studies empirically rejected the main predictions of the REPIH, while Flavin (1981) presents a model which effectively captured excess sensitivity of consumption using US macro data. An excellent and more recent adoption of this methodology can be found in Souleles (2001) and Melvin (2003), which also present results that suggest a rejection of the REPIH.

### **8.1 SUMMARY**

This study attempts to provide future substantial insights into the determinants of individuals' expectations and the nature of household consumption dynamics over the life cycle and to examine the causes of the failure of the baseline theory at the micro level. It is divided into six parts. The first provides a summary of the existing literature on household consumption of the last 50 years. The more recent literature on both rational expectations and consumption are presented. This review is followed by a more detailed description of the REH and the REPIH, the theoretical model for explaining consumption behaviour at the micro level which forms the basis of this study, and presents the main theoretical and empirical explanations that have been given for the failure of the REPIH. As a result, there are three findings drawn from the literature.

- a) There is no common consensus about what the underlying consumption function should look like.
- b) These tests are out of date and based on a limited amount of data. Researchers show more interest in micro panel and macro time-series data sets in the past decade.
- c) The evidence against the REPIH suggests it should be possible to identify some variables that should prove useful for predicting changes in consumption.

To explain actual consumption patterns leads to two main empirical objectives of the research: to quantify the failure of the REPIH using micro subjective data; and to explain what factors or behaviours account for this failure. In addition, one of the main assumptions in the REPIH, the Rational Expectations Hypothesis, is reviewed in this chapter. As a result, the evidence in previous studies is not strong enough to reject the REH, and the direct test of the REH at the micro level is an appropriate and worthwhile activity.

The third chapter presents the advantages of using micro-level panel data for identifying the factors which may explain the failure of the REPIH. The virtue and limitations of micro-data applications are both presented in this chapter. Three reasons are cited to explain the boom in micro data application. In particular, the general information on the BHPS database is briefly introduced. The distinctive properties in the BHPS, random sampling and the dynamics of change of the whole population in the UK, are emphasized by the four advantages of the BHPS. Then, a preliminary analysis of main observation variables (consumption, income, financial wellbeing variables, and others) derived from the BHPS give more details with respect to the interest variables in this thesis. A plot shows that household consumption rises up, as far as an individual's middle age and then starts falling thereafter. This hump shape is often used as a starting point for doubting the theoretical prediction of consumption smoothness.

The fourth chapter, following on from the characteristics of the BHPS variable employed in the study, introduces three existing panel data models

that can be used to analyse these characteristics, and provides the reasons for choosing a random effects ordered probit model. The highlights of random effects models are presented relative to the limitations of fixed effects models. Consequently, the match between the properties of the data derived from the BHPS, and the requirement of the models, led to the availability of the random effects models used in this study.

Chapters 5, 6 and 7 form the main empirical parts of the thesis. Chapter 5 presents a major empirical analysis of the subjective financial welfare data and investigates whether the REH is the best available objective method for modelling the individual expectations by identifying the types of individuals whose expectations were structurally incorrect. According to the lack in the previous studies, micro-heterogeneity and a short time period, the value of the REH test in this thesis is highlighted. Expectation errors are found consistently positively over 12 years, and demographic variables are jointly significant. These results indicate that expectations are biased and inefficient. As a result, the assumption on rational expectations, or the absence of macro-economic shocks, is invalid. Further, I explore the determinants of individuals' financial expectations. Expectations and expectation errors in different social sub-groups were investigated. There exists significant micro-heterogeneity in expectations and forecast capabilities across sub-groups. In other words, I identify particular groups prone to financially optimistic or pessimistic. Expectation errors are highlighted in the analysis because the findings suggest these are more complex than is usually assumed in empirical tests of forward-looking models. I interpret the results by characterizing the type of shocks that hit different types of individuals over time. Such a characterization is of the methodological interest.

Chapter 5 found expectations were not rational, and the existence of micro-heterogeneity, systematic errors and any assumption on the homogeneity of preferences and information sets might lead to inefficient evaluations. Attention then turns to whether the individual subjective information helps predict household expenditure in Chapter 6, by exploring the relationship

between an individual's financial change expectations and household consumption, following in Souleles's (2001) footsteps. The first set of results suggest significant evidence of excess sensitivity in the whole sample, while in the sub-sample investigation, employees, the self-employed and higher degree holders showed excess sensitivity, although individuals in other sub-samples appear to follow the predictions of the REPIH. A second set of estimates then investigated whether the existence of myopia, liquidity constraints, and asymmetric preferences were the likely causes of this excess consumption sensitivity. The results indicated that consumption changes were highly sensitive to financial resource declines, but not to financial resource increases. Under the assumption of myopic consumption behaviour, one would expect a symmetric response, in which consumption adjusts equally to unanticipated financial resource increases and decreases. Similarly, under the assumption of liquidity constraints, if financial resources are anticipated to fall, individuals could save in advance to keep their consumption constant, even when resource actually falls. Thus, consumption should be more sensitive to income increases. However the results neither confirmed myopia nor presented a strong argument in favour of liquidity constraints. Instead, the results suggest that asymmetric preferences are the most important cause of excess sensitivity in this study. It is noted that an exceptional case is the self-employed subgroup. Their consumption decision significantly responds to their financial wellbeing improvement. As a result, the excess sensitivity of the self-employed is due to the liquidity constraints.

Chapter 7 provided another possible explanation of excess sensitivity - systematic heterogeneity in expectation errors. With the help of Flavin's model, I investigate the relationship between consumption changes and anticipated and unanticipated shocks. The coefficients of expectation errors are significant and positive, while the coefficients of expectations become insignificant. This suggests that expectation errors play an important role and need to be considered in excess sensitivity tests. Further, the remaining significant coefficients of expectations in the self-employed and the secondary-educated indicate that their excess sensitivity in these two social

groups is not due to systematic heterogeneity in expectation errors alone. This significant finding in this chapter sheds light on the likely reasons for consumption non-smoothness.

## 8.2 CONCLUDING REMARKS

In sum, excess sensitivity is a critical finding of the present study. For the first time in the literature, to my knowledge, an attempt has been made to understand the divergence in the patterns of expenditure using subjective data from British households. Many studies in the past have discussed consumption behaviour using aggregated data. What I proposed, in this study, is a way of exploring the cross-sectional variation in financial wealth expectations, which contained information not included in the other macro variables used in forecasting. Of the BHPS survey questions, those asking specifically about the household, rather than the aggregate economy, were found to contain the most useful cross-sectional information. My thesis seems to derive a benchmark case study for the United Kingdom economy to help analyze some empirical puzzles.

This thesis examined the role of individuals' expectations in consumer behaviour and produced four interesting results. First, I explore the relationship between the financial realization at time  $t+1$  and financial expectations at time  $t$  by formulating a financial expectation errors index and reject the Rational Expectations Hypothesis. Individuals having experienced deterioration (improvement) have a higher probability of being financially pessimistic (optimistic). In terms of the magnitude of the effects, the estimated coefficients on the control for financial optimism in the previous time period outweigh those for financial pessimism and are statistically different from them at the 15 per cent level. Young individuals are much more financially optimistic than the old. Financial optimism is negatively associated with income: a 1 per cent increase in income raises the probability of being financially pessimistic by around 3 per cent. Also I find different social groups have different financial expectations: the married, women, house owners, individuals living in small sized household or in East Anglia and Wales have

lower probability of being financial pessimistic; meanwhile smokers, individuals with mortgage, the unemployed, individuals living in medium sized households or with two children have higher probability of being financial optimistic. I interpret the results by characterizing the type of shocks that hit different types of individuals over time. Such a characterization is of methodological interest. In particular, using UK panel data, my empirical findings help to inform economists not only about the determinants of individuals' expectations, rationality, but also about how expectations vary over the life cycle and the business cycle.

Secondly, this thesis explores whether accuracy of past expectations and individual characteristics influence their ability of forecasting in the following time period. The results show that individuals significantly overestimate their expectation when they realize their financial position has worsened over the past year, while those whose financial situation has improved have a larger probability of underestimating future increases than others. The married, women, employees, and individuals living in East Anglia are financially over-pessimistic; meanwhile smokers, the unemployed, and individuals with one child are financially over-optimistic. My findings add to the developing literature on expectations formation and contribute to an expanding area of research.

Thirdly, my results reject the Rational Expectations Permanent Income Hypothesis in the whole sample. This rejection occurs as a result of the significance of lagged values of the changes in the financial wellbeing in explaining the rate of growth in non-durable consumption expenditure. In other words, current financial expectations do appear to help predict change in consumption. This result casts doubt upon the REPIH as it is usually applied. Further, one of the most encouraging outcomes obtained from this analysis is that the empirical work on the aggregate level is not very effective in testing the REPIH. On a micro level, we find that some respondents surveyed form non-durable consumption expenditure decisions in line with the REPIH, such as individuals with comparatively lower education levels.

The others named as the excess sensitivity groups, such as the highly educated, employee, and the self-employed, behave against the REPIH. Further analysis, by estimating a structural equation relating the change in consumption to both anticipated and unanticipated financial situation shocks, suggests that asymmetric preference and systematic heterogeneity in expectation errors are main possible sources leading to the failure of the REPIH among the highly educated and employees. For the self-employed, the combination of liquidity constraints and systematic heterogeneity in expectation errors make the REPIH fail.

Fourthly, the asymmetric response of agents' consumption changes to expected financial improvement and deterioration exists in all of our investigations. This result is in accord with the central assumption of loss-aversion, in which loss and disadvantage have greater impact on preferences than gain and advantage. This thesis provides an empirical observation of this discrepancy.

To conclude, changes in individuals' expectations/beliefs are an intuitively attractive source of consumption fluctuations. Investigation of their importance relative to other alternative sources faces many conceptual, theoretical and empirical challenges. Many open research questions remain.

### **8.3 FURTHER IMPLICATIONS AND EXTENSIONS**

Understanding how individuals formulate their expectations and identifying those groups prone to financial optimistic or pessimistic is insight for policymakers, given the potential role of consumer confidence in influencing economic activity such as consumption and saving. For example, my findings serve to inform policymakers about how different groups in the economy may react to change in economic policy that influence the financial situation faced by individuals and households. This thesis presents an interesting connection between household expectations and how they are incorporated into household behaviour. The results suggest the individuals prone to financial optimistic and display the expected relationship between financial

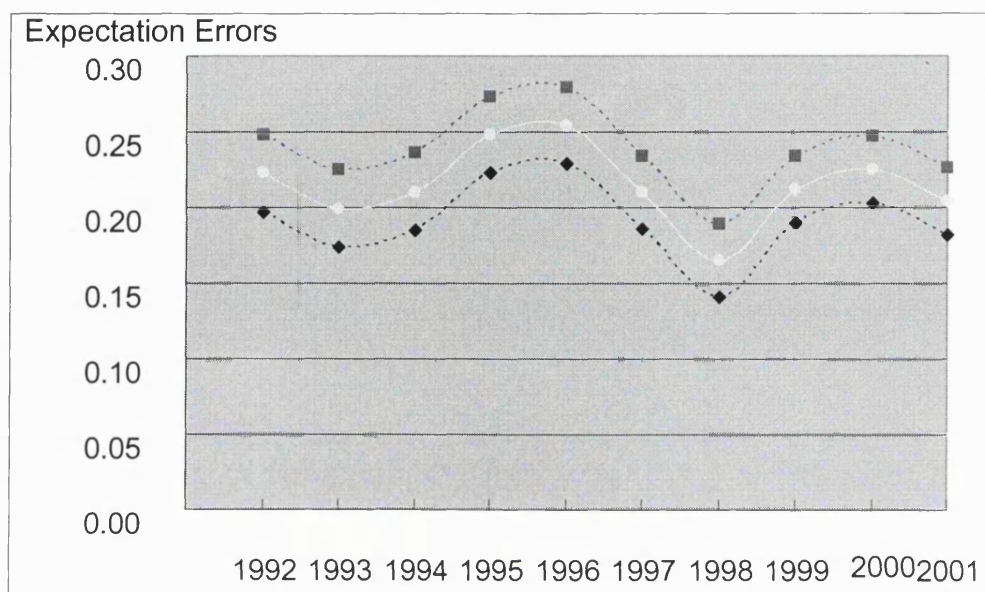
wellbeing expectations and household consumption. They do suggest the need for more research to assess the empirical relationship between expectations and economic behaviour. The availability of subjective expectations information offers an exciting opportunity to validate the importance of expectations in decision-making that are an integral part of economic theory. Moreover, a marked asymmetry in the responses to favourable or unfavourable changes in economic condition will be noted in the standard models of decision making. This thesis can be extended in a number of ways. First, given the significance of the cross-sectional distribution of individual expectations, new subjective survey questions might be created to better incorporate this distribution. Secondly, one can similarly examine many other decisions in addition to consumption for which expectations matter. Third, durable consumption might be taken into account in modelling. Fourth, a decision maker who seeks to maximize the utility of outcomes might be well advised to assign greater weight to negative rather than positive consequence in the extended forward-looking models.



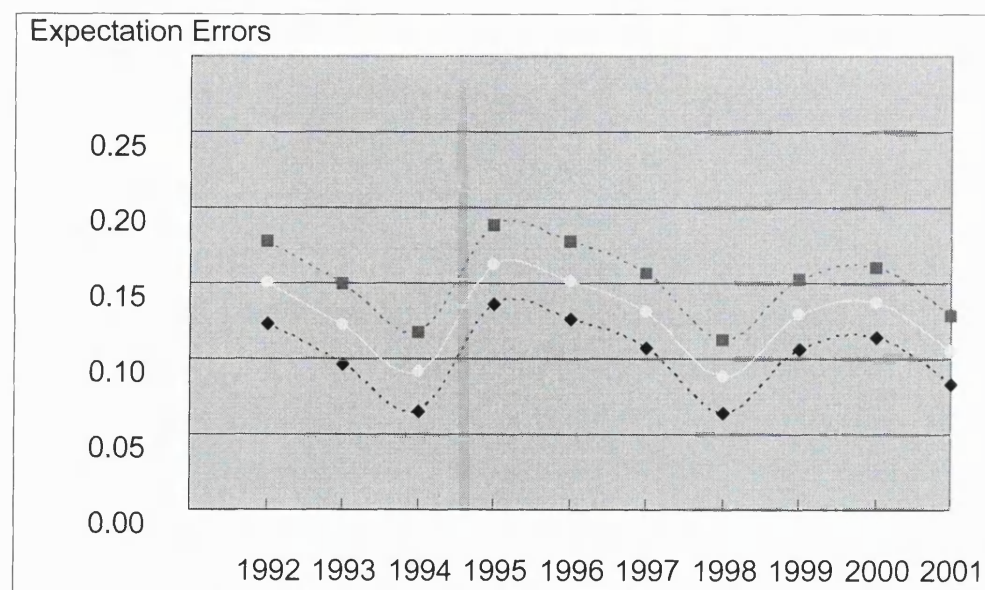
## APPENDICES

### Appendix A

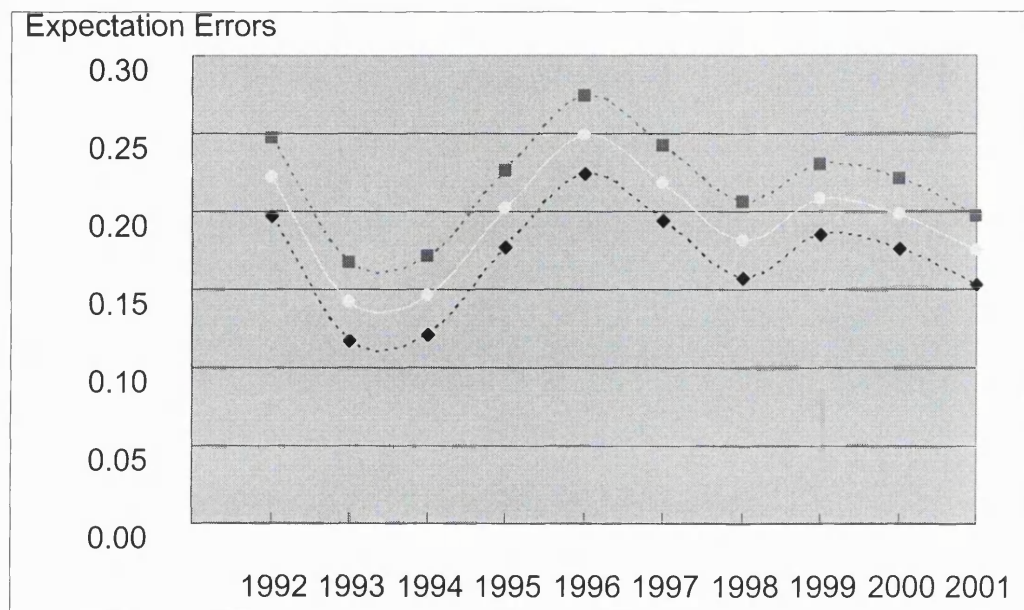
#### Unbiasedness Test in Sub-Samples



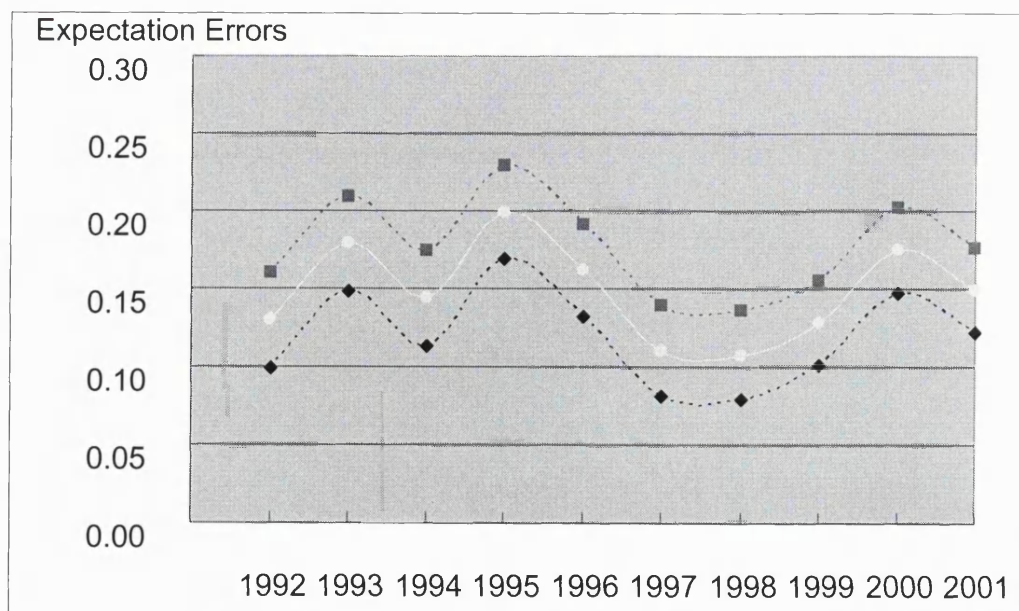
Male (unbalanced): #obs = 63031, LR Chi2(10) = 148.51,  $\rho = 0.104$



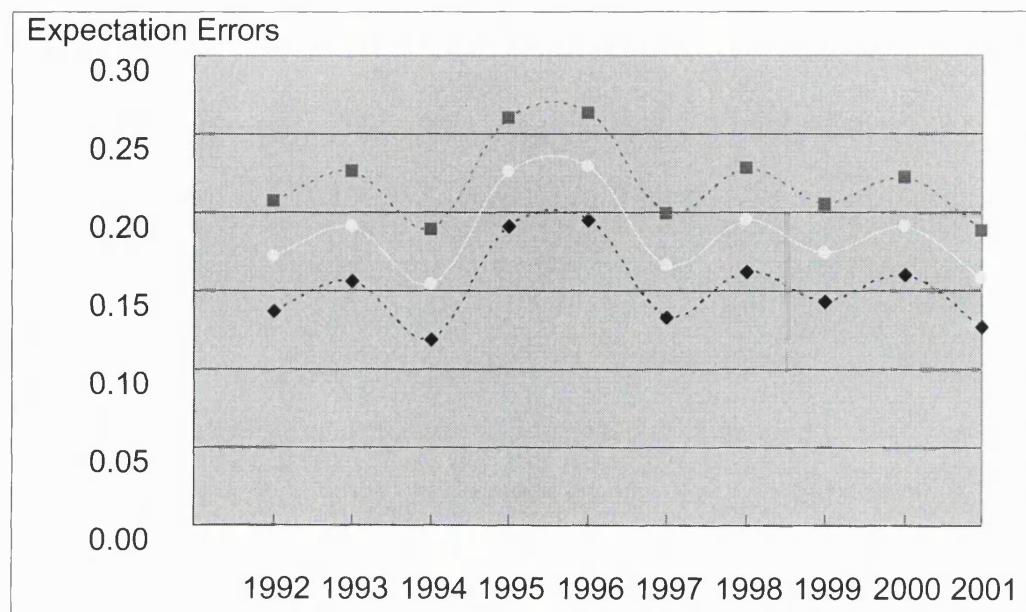
Female (Unbalanced): #obs = 62003, LR Chi2(10) = 62.98,  $\rho = 0.107$



Married (unbalanced): #obs = 51054, LR Chi2(10) = 149.05,  $\rho = 0.097$

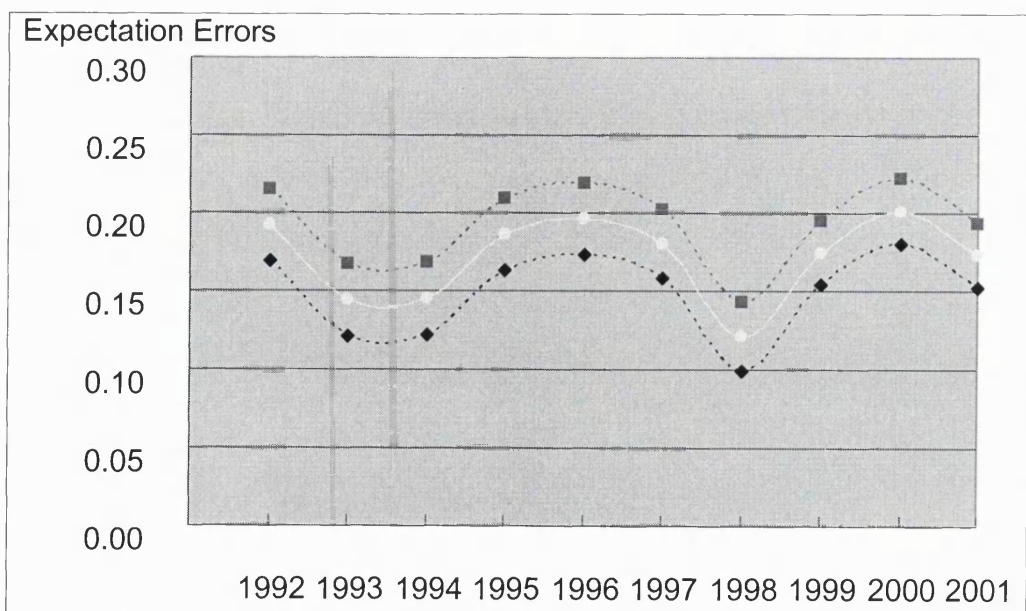


Unmarried (unbalanced): #obs = 40211, LR Chi2(10) = 65.08,  $\rho = 0.119$



Secondary Education (unbalanced): #obs = 30961,  
 LR Chi2(10) = 62.15,  $\rho = 0.105$

#### Higher Education



Higher Education (unbalanced): #obs = 59845,  
 LR Chi2(10) = 132.86,  $\rho = 0.103$

## Appendix B

**Table 1 Efficiency Test**

*Dependent Variable = Fisite (BHPS: 1991~2002)*

	<i>Whole Sample</i>			<i>Male</i>			<i>Female</i>			<i>Married</i>			<i>Unmarried</i>		
<i>Probit Model</i>	<i>Mean</i>	<i>Coef</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>
<i>Age</i>	44.88	-0.0088*	-5.080	44.88	-0.0201*	-12.290	43.81	-0.0219*	-13.970	48.89	-0.004	-1.400	40.25	-0.010*	-4.000
<i>AgeAge/100</i>	23.63	0.0125*	7.160	23.63	0.0224*	12.710	22.90	0.0241*	14.310	26.08	0.0076*	2.580	20.81	0.0135*	5.610
<i>Log of Income</i>	71.95	0.1388*	22.040	3.89	0.0761*	14.120	3.64	0.0738*	13.860	4.05	0.1342*	16.330	3.59	0.1741*	15.780
<i>Income Varance</i>	-	0.0000*	-2.500	-	0.0000*	-2.450	-	0.0000	-0.710	-	0.0000	-1.920	-	0.0000	-0.930
<i>No married</i>	0.46	-	-	0.46	-	-	0.52	-	-	--	-	-	--	-	-
<i>Married</i>	0.54	0.0838*	6.330	0.54	0.0703*	5.340	0.48	0.1159*	9.040	--	--	--	--	--	--
<i>Male</i>	0.50	-	-	0.50	-	-	-	-	-	0.53	-	-	0.47	-	-
<i>Female</i>	0.50	0.1180*	12.460	0.50	-	-	-	-	-	0.47	0.1539*	11.860	0.53	0.0524*	3.390
<i>No Smoker</i>	0.71	-	-	0.71	-	-	0.70	-	-	0.75	-	-	0.66	-	-
<i>Smokers</i>	0.29	-0.0886*	-8.540	0.29	-0.1060*	-10.490	0.30	-0.1005*	-9.760	0.25	-0.0805*	-5.840	0.34	-0.0887*	-5.380
<i>Housing Owned</i>	0.24	-	-	0.24	-	-	0.23	-	-	0.26	-	-	0.21	-	-
<i>Housing Mortgage</i>	0.48	-0.0385*	-3.070	0.48	-0.0039	-0.310	0.47	-0.0001	0.000	0.55	-0.0406*	-2.490	0.40	-0.0321	-1.530
<i>Housing Rented</i>	0.28	-0.0164	-1.220	0.28	-0.0759*	-5.540	0.30	-0.0702*	-5.200	0.18	-0.0119	-0.620	0.39	-0.0089	-0.450
<i>Secondary Education</i>	0.02	0.0527	1.740	0.02	0.1058*	3.640	0.02	0.0308	0.940	0.02	0.0447	1.160	0.02	0.0810	1.560
<i>Higher Education</i>	0.33	-	-	0.33	-	-	0.32	-	-	0.48	-	-	0.48	-	-
<i>Others</i>	0.65	-0.0155	-1.510	0.65	0.0054	0.550	0.67	-0.0019	-0.180	0.67	-0.0313*	-2.390	0.63	0.0184	1.060
<i>In Paid employed</i>	0.54	-	-	0.54	-	-	0.54	-	-	0.59	-	-	0.49	-	-
<i>Self employment</i>	0.08	-0.1150*	-6.950	0.08	-0.0862*	-5.330	0.05	-0.0950*	-4.610	0.10	-0.1220*	-6.160	0.05	-0.0803*	-2.490
<i>Unemployed</i>	0.05	-0.3710*	-14.320	0.05	-0.3815*	-16.860	0.04	-0.3961*	-15.400	0.03	-0.2630*	-6.750	0.07	-0.4388*	-12.020
<i>Retired</i>	0.21	-0.0611*	-3.200	0.21	-0.0558*	-2.670	0.21	-0.0478*	-2.320	0.22	-0.0734*	-3.100	0.21	-0.0002	-0.010
<i>Others</i>	0.13	-0.0224	-1.140	0.13	0.1669*	10.050	0.15	0.1430*	8.700	0.07	-0.0822*	-3.060	0.19	0.0759*	2.520
<i>No Child</i>	0.74	-	-	0.74	-	-	0.75	-	-	0.62	-	-	0.88	-	-
<i>1 Child</i>	0.11	-0.0818*	-5.560	0.11	-0.0894*	-6.000	0.11	-0.0707*	-4.810	0.15	-0.0778*	-4.240	0.07	-0.0761*	-2.480
<i>2 Children</i>	0.11	-0.0738*	-4.790	0.11	-0.0973*	-6.150	0.10	-0.0897*	-5.490	0.16	-0.0848*	-4.560	0.04	-0.0681	-1.750

<i>3+ Children</i>	0.04	-0.0858*	-3.730	0.04	-0.0913*	-4.020	0.04	-0.1113*	-4.410	0.07	-0.1079*	-4.180	0.01	-0.0126	-0.160
<i>Small HH Size</i>	0.17	-0.0259	-1.630	0.17	0.0198	1.220	0.18	0.0212	1.360	0.01	0.0317	0.370	0.36	-0.0209	-1.120
<i>Medium HH Size</i>	0.53	-	-	0.53	-	-	0.51	-	-	0.73	-	-	0.30	-	-
<i>Big HH Size</i>	0.30	-0.0042	-0.380	0.30	0.0393*	3.620	0.31	0.0289*	2.580	0.26	-0.0460*	-3.320	0.34	0.0712*	3.180
<i>London</i>	0.08	0.0103	0.590	0.08	-0.0346	-1.790	0.07	-0.0196	-1.000	0.07	0.0035	0.150	0.09	0.0294	1.060
<i>Southeast</i>	0.20	-	-	0.20	-	-	0.21	-	-	0.16	-	-	0.15	-	-
<i>Southwest</i>	0.07	0.0104	0.600	0.07	0.0119	0.630	0.06	-0.0247	-1.250	0.08	-0.0224	-1.020	0.07	0.0762*	2.570
<i>East Anglia</i>	0.03	0.0607*	2.620	0.03	0.0385	1.490	0.03	0.0407	1.500	0.04	0.0673*	2.360	0.03	0.0840*	2.020
<i>Midlands</i>	0.14	0.0272	1.870	0.14	-0.0089	-0.580	0.13	-0.0208	-1.320	0.14	0.0153	0.840	0.14	0.0592*	2.360
<i>Yorksires</i>	0.08	0.0462*	2.690	0.08	0.0145	0.760	0.07	0.0010	0.050	0.08	0.0618*	2.860	0.07	0.0352	1.180
<i>Wales</i>	0.11	0.0162	0.760	0.11	-0.0197	-1.210	0.13	-0.0620*	-3.790	0.11	-0.0259	-0.940	0.11	0.0936*	2.700
<i>Scotland</i>	0.14	0.0266	1.490	0.14	0.0072	0.470	0.17	-0.0404*	-2.700	0.14	0.0066	0.290	0.15	0.0711*	2.430
<i>Greater Manchester</i>	0.03	0.0352	1.460	0.03	-0.0287	-1.080	0.03	-0.0211	-0.810	0.03	0.0144	0.460	0.04	0.1055*	2.730
<i>North</i>	0.11	0.0349*	2.240	0.11	-0.0010	-0.060	0.09	0.0037	0.220	0.11	0.0126	0.640	0.10	0.0851*	3.190
<i>LR chi2(39)=</i>	1837.3		<i>LR chi2(38)=</i>		1616.93		1383.88		938.23		928.08				
<i>Pseudo R2</i>	0.012		<i>Pseudo R2</i>		0.0105		0.0093		0.0101		0.0168				
<i>Number of Obs.</i>	60648				60086		58760		37141		21801				



Dependent Variable = Fisite (BHPS: 1991~2002)

Probit Model	Secondary Edu.			High Education			Others			.	.	.
	Mean	Coef	T-Stat.	Mean	Coef.	T-Stat.	Mean.	Coef.	T-Stat.			
Age	38.04	-0.0087*	-2.480	48.17	-0.0053*	-2.500	42.32	0.0124	0.750	--	--	--
Age/Age/100	16.75	0.0098*	2.520	26.99	0.0107*	5.190	19.71	-0.0209	-1.240	--	--	--
Log of Income	4.12	0.1794*	16.690	3.67	0.1092*	13.250	4.68	0.2369*	5.440	--	--	--
Income Variance	-	0.0000*	-3.140	-	0.0000*	-2.630	-	0.0000	1.680	--	--	--
No married	0.49	-	-	0.45	-	-	0.40	-	-	--	--	--
Married	0.51	0.1171*	5.130	0.55	0.0560*	3.340	0.60	0.0754	0.820	--	--	--
Male	0.57	-	-	0.48	-	-	0.61	-	-	--	--	--
Female	0.43	0.1417*	8.680	0.52	0.1010*	8.380	0.39	-0.0099	-0.150	--	--	--
No Smoker	0.76	-	-	0.68	-	-	0.87	-	-	--	--	--
Smokers	0.24	-0.1006*	-5.130	0.32	-0.0839*	-6.750	0.13	0.0222	0.200	--	--	--
Housing Owned	0.19	-	-	0.27	-	-	0.19	-	-	--	--	--
Housing Mortgage	0.60	-0.0828*	-3.500	0.42	-0.0249	-1.620	0.66	-0.2905*	-2.910	--	--	--
Housing Rented	0.21	-0.0941*	-3.150	0.32	0.0012	0.080	0.14	-0.3575*	-2.700	--	--	--
Secondary Education	--	--	--	--	--	--	--	--	--	--	--	--
Higher Education	--	--	--	--	--	--	--	--	--	--	--	--
Others	--	--	--	--	--	--	--	--	--	--	--	--
In Paid employed	0.66	-	-	0.48	-	-	0.75	-	-	--	--	--
Self employment	0.09	-0.0897*	-3.350	0.07	-0.1034*	-4.760	0.09	-0.2659*	-2.350	--	--	--
Unemployed	0.03	-0.4689*	-9.400	0.05	-0.3443*	-11.060	0.03	-0.0553	-0.220	--	--	--
Retired	0.09	-0.0697	-1.710	0.27	-0.0873*	-3.950	0.08	0.1927	1.090	--	--	--
Others	0.13	0.0426	1.170	0.13	-0.0781*	-3.250	0.05	0.3375*	2.120	--	--	--
No Child	0.71	-	-	0.76	-	-	0.67	-	-	--	--	--
1 Child	0.13	-0.0816*	-3.390	0.10	-0.0716*	-3.690	0.15	-0.2766*	-3.060	--	--	--
2 Children	0.12	-0.1205*	-4.880	0.10	-0.0349	-1.680	0.13	-0.1266	-1.300	--	--	--
3+ Children	0.04	-0.1192*	-2.950	0.04	-0.0460	-1.580	0.04	-0.3319*	-2.090	--	--	--
Small HH Size	0.14	-0.0159	-0.580	0.18	-0.0369	-1.840	0.17	-0.0658	-0.620	--	--	--
Medium HH Size	0.56	-	-	0.51	-	-	0.65	-	-	--	--	--
Big HH Size	0.30	0.0079	0.400	0.30	-0.0103	-0.740	0.18	0.0677	0.770	--	--	--
London	0.09	0.0279	0.960	0.07	0.0056	0.240	0.16	-0.0800	-0.810	--	--	--
Southeast	0.21	-	-	0.20	-	-	0.24	-	-	--	--	--
Southwest	0.06	0.0449	1.390	0.08	0.0053	0.250	0.05	-0.0717	-0.570	--	--	--
East Anglia	0.03	0.0725	1.750	0.03	0.0584*	2.070	0.02	0.1468	0.410	--	--	--
Midlands	0.13	0.0340	1.310	0.15	0.0205	1.130	0.12	-0.0104	-0.100	--	--	--
Yorkshires	0.07	0.0811*	2.600	0.08	0.0335	1.580	0.07	-0.1483	-1.340	--	--	--
Wales	0.10	0.0424	1.180	0.11	0.0128	0.480	0.06	-0.3350	-1.370	--	--	--
Scotland	0.18	0.0154	0.540	0.12	0.0265	1.120	0.21	-0.0367	-0.340	--	--	--
Greater Manchester	0.03	0.0400	0.980	0.03	0.0291	0.960	0.02	0.5027*	1.990	--	--	--
North	0.09	0.0085	0.310	0.11	0.0497*	2.580	0.06	-0.1636	-1.290	--	--	--
LR chi2(37)=		813			1022.31			115.38				
Pseudo R2		0.0158			0.0106			0.0334				
Number of Obs.		19229			39903			1281				

Sources: 1991 to 2002 yearly BHPS samples.

- 1) UK CPI for obtaining real income figures in 1991.
- 2) \* = significant at 5%.
- 3) Year dummies are jointly estimated.
- 4) Null hypothesis: coefficient corresponding to explanatory variable is equal to zero.

**Table 2 Properties of Financial Expectations**

*Dependent Variable = Fisitx (BHPS: 1991~2002)*

<i>Probit Model</i>	<i>Whole Sample</i>			<i>Male</i>			<i>Female</i>			<i>Married</i>			<i>Unmarried</i>		
	<i>Mean</i>	<i>Coef</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>
<i>Deteriorated</i>	0.24	-0.2089*	-19.460	0.23	-0.0950*	-8.910	0.23	-0.0485*	-4.520	0.24	-0.2426*	-17.960	0.24	-0.1496*	-8.410
<i>Same</i>	0.47	-	-	0.46	-	-	0.48	-	-	0.51	-	-	0.43	-	-
<i>Improved</i>	0.29	0.3612*	32.410	0.31	0.3234*	31.380	0.30	0.3024*	29.210	0.25	0.4062*	28.710	0.33	0.2936*	16.150
<i>Age</i>	44.88	-0.0413*	-24.390	44.88	-0.0324*	-20.830	43.81	-0.0347*	-23.590	40.25	-0.0365*	-12.890	40.25	-0.0509*	-21.890
<i>Age.Age/100</i>	23.63	0.0250*	14.580	23.63	0.0177*	10.550	22.90	0.0214*	13.640	20.81	0.0189*	6.670	20.81	0.0355*	15.230
<i>Log of Income</i>	71.95	-0.0311*	-5.250	3.89	0.0043	0.910	3.64	0.0044	0.940	3.59	-0.0410*	-5.350	3.59	-0.0113	-1.110
<i>Income Variance.</i>	-	0.0000*	8.600	-	0.0000*	8.350	-	0.0000*	3.920	-	0.0000*	6.850	-	0.0000*	5.160
<i>No married</i>	0.46	-	-	0.46	-	-	0.52	-	-	--	--	--	--	--	--
<i>Married</i>	0.54	-0.0963*	-7.290	0.54	-0.1294*	-10.360	0.48	-0.1169*	-9.680	--	--	--	--	--	--
<i>Male</i>	0.50	-	-	--	--	--	--	--	--	0.47	-	-	0.47	-	-
<i>Female</i>	0.50	-0.0593*	-6.250	--	--	--	--	--	--	0.53	-0.0623*	-4.840	0.53	-0.0748*	-4.940
<i>No Smoker</i>	0.71	-	-	0.71	-	-	0.70	-	-	0.66	-	-	0.66	-	-
<i>Smokers</i>	0.29	0.0753*	7.330	0.29	0.0872*	9.180	0.30	0.0910*	9.520	0.34	0.0769*	5.720	0.34	0.0708*	4.410
<i>Housing Owned</i>	0.24	-	-	0.24	-	-	0.23	-	-	0.21	-	-	0.21	-	-
<i>Housing Mortgage</i>	0.48	0.0817*	6.520	0.48	0.0632*	5.160	0.47	0.0697*	5.690	0.40	0.0643*	3.960	0.40	0.0836*	4.070
<i>Housing Rented</i>	0.28	0.0461*	3.460	0.28	0.0752*	5.840	0.30	0.0840*	6.690	0.39	0.0030	0.160	0.39	0.0763*	3.930
<i>Secondary Education</i>	0.02	-0.0133	-0.430	0.02	0.0202	0.720	0.02	0.0607	1.930	0.02	-0.0051	-0.130	0.02	-0.0257	-0.490
<i>Higher Education</i>	0.33	-	-	0.33	-	-	0.32	-	-	0.48	-	-	0.48	-	-
<i>Others</i>	0.65	-0.0120	-1.160	0.65	-0.0110	-1.180	0.67	0.0199*	2.040	0.63	0.0024	0.190	0.63	-0.0350*	-2.050
<i>In Paid employed</i>	0.54	-	-	0.54	-	-	0.54	-	-	0.49	-	-	0.49	-	-
<i>Self employment</i>	0.08	0.2080*	12.440	0.08	0.1702*	10.800	0.05	0.1593*	8.150	0.05	0.1888*	9.570	0.05	0.2591*	8.100
<i>Unemployed</i>	0.05	0.3618*	14.630	0.05	0.3436*	16.640	0.04	0.3853*	16.920	0.07	0.2106*	5.830	0.07	0.4838*	13.940
<i>Retired</i>	0.21	-0.0919*	-4.850	0.21	-0.1168*	-5.850	0.21	-0.1716*	-8.970	0.21	-0.0455	-1.930	0.21	-0.1551*	-4.680
<i>Others</i>	0.13	-0.2015*	-11.170	0.13	-0.4362*	-28.820	0.15	-0.3945*	-27.350	0.19	-0.1064*	-4.390	0.19	-0.2973*	-10.780
<i>No Child</i>	0.74	-	-	0.74	-	-	0.75	-	-	0.88	-	-	0.88	-	-
<i>1 Child</i>	0.11	-0.0007	-0.050	0.11	-0.0231	-1.620	0.11	-0.0073	-0.520	0.07	-0.0029	-0.160	0.07	-0.0106	-0.360
<i>2 Children</i>	0.11	0.0652*	4.270	0.11	0.0412*	2.710	0.10	0.0875*	5.710	0.04	0.0792*	4.400	0.04	0.0242	0.670
<i>3+ Children</i>	0.04	0.0092	0.410	0.04	-0.0129	-0.600	0.04	0.0192	0.840	0.01	0.0482	1.930	0.01	-0.1841*	-2.820

<i>Small HH Size</i>	0.17	-0.0379*	-2.390	0.17	-0.1013*	-6.570	0.18	-0.1243*	-8.470	0.36	-0.0098	-0.130	0.36	-0.0806*	-4.430
<i>Medium HH Size</i>	0.53	-	-	0.53	-	-	0.51	-	-	0.30	-	-	0.30	-	-
<i>Big HH Size</i>	0.30	-0.0096	-0.870	0.30	-0.0427*	-4.170	0.31	-0.0302*	-2.900	0.34	0.0331*	2.410	0.34	-0.1132*	-5.190
<i>London</i>	0.08	-0.0306	-1.760	0.08	0.0174	0.940	0.07	0.0104	0.560	0.09	-0.0600*	-2.610	0.09	-0.0107	-0.400
<i>Southeast</i>	0.20	-	-	0.20	-	-	0.21	-	-	0.15	-	-	0.15	-	-
<i>Southwest</i>	0.07	-0.0277	-1.590	0.07	-0.0432*	-2.390	0.06	0.0069	0.370	0.07	-0.0084	-0.390	0.07	-0.0653*	-2.260
<i>East Anglia</i>	0.03	-0.0829*	-3.560	0.03	-0.0650*	-2.570	0.03	-0.0469	-1.810	0.03	-0.0691*	-2.440	0.03	-0.1150*	-2.810
<i>Midlands</i>	0.14	-0.0120	-0.820	0.14	0.0312*	2.130	0.13	0.0272	1.850	0.14	-0.0096	-0.530	0.14	-0.0183	-0.750
<i>Yorkshires</i>	0.08	-0.0481*	-2.800	0.08	-0.0408*	-2.230	0.07	-0.0206	-1.130	0.07	-0.0430*	-2.010	0.07	-0.0644*	-2.230
<i>Wales</i>	0.11	-0.0766*	-3.640	0.11	-0.0063	-0.420	0.13	0.0089	0.600	0.11	-0.0190	-0.700	0.11	-0.1659*	-4.930
<i>Scotland</i>	0.14	0.0084	0.470	0.14	0.0459*	3.290	0.17	0.0643*	4.680	0.15	0.0358	1.570	0.15	-0.0308	-1.080
<i>Greater Manchester</i>	0.03	-0.0302	-1.250	0.03	0.0298	1.150	0.03	0.0085	0.340	0.04	-0.0248	-0.790	0.04	-0.0437	-1.150
<i>North</i>	0.11	-0.0320*	-2.050	0.11	-0.0236	-1.470	0.09	-0.0269	-1.660	0.10	-0.0167	-0.850	0.10	-0.0644*	-2.470
<i>LR chi2(42)=</i>	11468.7		<i>LR chi2(41)=</i>		12491.13		11977.78		5958.89		5402.25				
<i>Pseudo R2</i>	0.0854				0.0835		0.0814		0.0724		0.1048				
<i>Number of Obs.</i>	72921				79895		80674		45383		27558				



Dependent Variable = *Fisitz* (BHPS: 1991~2002)

Probit Model	Secondary Edu.			High Education			Others		
	Mean	Coef	T-Stat.	Mean	Coef.	T-Stat.	Mean.	Coef.	T-Stat.
<i>Deteriorated</i>	0.25	-0.010	-0.510	0.24	-0.3159*	-24.150	0.20	0.15	1.82
<i>Same</i>	0.39	-	-	0.52	-	-	0.40	-	-
<i>Improved</i>	0.36	0.337*	18.230	0.25	0.4001*	27.810	0.40	0.3502*	4.920
<i>Age</i>	38.04	-0.0257*	-7.380	48.17	-0.0492*	-23.850	44.88	-0.0330*	-2.030
<i>AgeAge/100</i>	16.75	0.0103*	2.690	26.99	0.0315*	15.630	23.63	0.0236	1.400
<i>Log of Income</i>	4.12	-0.069*	-6.850	3.67	-0.0024	-0.310	3.84	-0.1048*	-2.690
<i>Income Variance.</i>	-	0.0000*	6.240	-	0.0000*	7.520	-	0.0000	-0.400
<i>No married</i>	0.49	-	-	0.45	-	-	0.46	-	-
<i>Married</i>	0.51	-0.1168*	-5.100	0.55	-0.0761*	-4.570	0.54	-0.1113	-1.210
<i>Male</i>	0.57	-	-	0.48	-	-	0.50	-	-
<i>Female</i>	0.43	-0.1296*	-7.960	0.52	-0.0099	-0.820	0.50	-0.1164	-1.740
<i>No Smoker</i>	0.76	-	-	0.68	-	-	0.71	-	-
<i>Smokers</i>	0.24	0.0870*	4.450	0.32	0.0711*	5.790	0.29	0.1760	1.590
<i>Housing Owned</i>	0.19	-	-	0.27	-	-	0.24	-	-
<i>Housing Mortgage</i>	0.60	0.1015*	4.290	0.42	0.0790*	5.150	0.48	0.3513*	3.480
<i>Housing Rented</i>	0.21	0.1630*	5.520	0.32	0.0167	1.090	0.28	0.4007*	3.060
<i>Secondary Education</i>	--	--	--	--	--	--	--	--	--
<i>Higher Education</i>	--	--	--	--	--	--	--	--	--
<i>Others</i>	--	--	--	--	--	--	--	--	--
<i>In Paid employed</i>	0.66	-	-	0.48	-	-	0.54	-	-
<i>Self employment</i>	0.09	0.1688*	6.250	0.07	0.2123*	9.680	0.08	0.2609*	2.290
<i>Unemployed</i>	0.03	0.5330*	10.760	0.05	0.3313*	11.320	0.05	0.8091*	3.240
<i>Retired</i>	0.09	0.0365	0.890	0.27	-0.0964*	-4.380	0.21	-0.1529	-0.860
<i>Others</i>	0.13	-0.3466*	-10.080	0.13	-0.1376*	-6.320	0.13	-0.0857	-0.550
<i>No Child</i>	0.71	-	-	0.76	-	-	0.74	-	-
<i>1 Child</i>	0.13	-0.0588*	-2.430	0.10	0.0298	1.560	0.11	-0.0973	-1.100
<i>2 Children</i>	0.12	0.0377	1.530	0.10	0.0761*	3.730	0.11	-0.0362	-0.360
<i>3+ Children</i>	0.04	0.0256	0.650	0.04	-0.0231	-0.820	0.04	0.2822	1.830
<i>Small HH Size</i>	0.14	-0.0501	-1.800	0.18	-0.0393*	-1.970	0.17	0.0234	0.220
<i>Medium HH Size</i>	0.56	-	-	0.51	-	-	0.53	-	-
<i>Big HH Size</i>	0.30	-0.0302	-1.540	0.30	0.0020	0.150	0.30	-0.1798*	-2.080
<i>London</i>	0.09	-0.0371	-1.270	0.07	-0.0235	-1.040	0.08	-0.1470	-1.500
<i>Southeast</i>	0.21	-	-	0.20	-	-	0.20	-	-
<i>Southwest</i>	0.06	-0.0671*	-2.080	0.08	-0.0131	-0.620	0.07	0.2388	1.870
<i>East Anglia</i>	0.03	-0.1227*	-2.950	0.03	-0.0510	-1.790	0.03	0.0727	0.230
<i>Midlands</i>	0.13	-0.0178	-0.690	0.15	0.0061	0.340	0.14	-0.1250	-1.200
<i>Yorkshires</i>	0.07	-0.0971*	-3.110	0.08	-0.0099	-0.470	0.08	-0.1389	-1.260
<i>Wales</i>	0.10	-0.0812*	-2.250	0.11	-0.0747*	-2.840	0.11	0.0881	0.340
<i>Scotland</i>	0.18	0.0016	0.060	0.12	0.0387	1.650	0.14	-0.1085	-1.020
<i>Greater Manchester</i>	0.03	-0.0827*	-2.020	0.03	0.0128	0.430	0.03	-0.1327	-0.530
<i>North</i>	0.09	-0.0328	-1.160	0.11	-0.0235	-1.220	0.11	-0.0545	-0.430
LR $\chi^2(40)=$	2700.84			8606.52			219.6		
Pseudo R2	0.062			0.099			0.075		
Number of Obs.	22719			8606.52			1522		

Sources: 1991 to 2002 yearly BHPS samples.

- 1) UK CPI for obtaining real income figures in 1991.
- 2) \* = significant at 5%.
- 3) Year dummies are jointly estimated.
- 4) Null hypothesis: coefficient corresponding to explanatory variable is equal to zero.

**Table 3 Properties of Expectation Errors**

*Dependent Variable = Fisite (BHPS: 1991~2002)*

	<i>Whole Sample</i>			<i>Male</i>			<i>Female</i>			<i>Married</i>			<i>Unmarried</i>		
<i>Probit Model</i>	<i>Mean</i>	<i>Coef</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>
<i>Deteriorated</i>	0.09	-0.2094*	-11.350	0.09	-0.2180*	-12.070	0.09	-0.2656*	-14.430	0.07	-0.200*	-7.690	0.24	-0.234*	-8.530
<i>Same</i>	0.27	-	-	0.27	-	-	0.27	-	-	0.26	-	-	0.43	-	-
<i>Improved</i>	0.64	0.3091*	29.310	0.64	0.3251*	30.890	0.64	0.3187*	29.800	0.68	0.322*	23.370	0.33	0.279*	16.160
<i>Age</i>	44.88	-0.0032	-1.820	44.88	-0.0141*	-8.530	43.81	-0.0153*	-9.690	40.25	-0.002	-0.710	40.25	-0.002	-1.020
<i>AgeAge/100</i>	23.63	0.0075*	4.260	23.63	0.0169*	9.540	22.90	0.0178*	10.510	20.81	0.0063*	2.130	20.81	0.0067*	2.750
<i>Log of Income</i>	71.95	0.1064*	16.700	3.89	0.0529*	9.740	3.64	0.0555*	10.370	3.59	0.1000*	12.020	3.59	0.1357*	12.120
<i>Income Variance</i>	-	0.0000*	-3.570	-	0.0000*	-3.770	-	0.0000	-1.670	-	0.0000*	-2.560	-	0.0000	-1.740
<i>No married</i>	0.46	-	-	0.46	-	-	0.52	-	-	--	-	-	--	-	-
<i>Married</i>	0.54	0.0472*	3.550	0.54	0.0533*	4.030	0.48	0.0773*	6.000	--	--	--	--	--	--
<i>Male</i>	0.50	-	-	-	-	-	-	-	-	0.47	-	-	0.47	-	-
<i>Female</i>	0.50	0.0947*	9.950	-	-	-	-	-	-	0.53	0.1132*	8.660	0.53	0.0573*	3.700
<i>No Smoker</i>	0.71	-	-	0.71	-	-	0.70	-	-	0.66	-	-	0.66	-	-
<i>Smokers</i>	0.29	-0.0555*	-5.320	0.29	-0.0649*	-6.380	0.30	-0.0608*	-5.870	0.34	-0.0494*	-3.560	0.34	-0.0538*	-3.240
<i>Housing Owned</i>	0.24	-	-	0.24	-	-	0.23	-	-	0.21	-	-	0.21	-	-
<i>Housing Mortgage</i>	0.48	-0.0081	-0.640	0.48	0.0204	1.580	0.47	0.0256*	1.960	0.40	-0.0024	-0.140	0.40	-0.0086	-0.410
<i>Housing Rented</i>	0.28	0.0475*	3.500	0.28	-0.0074	-0.530	0.30	0.0055	0.400	0.39	0.0659*	3.410	0.39	0.0392*	1.960
<i>Secondary Education</i>	0.02	0.0495	1.640	0.02	0.0871*	2.990	0.02	0.0156	0.480	0.02	0.0330	0.860	0.02	0.0883	1.700
<i>Higher Education</i>	0.33	-	-	0.33	-	-	0.32	-	-	0.48	-	-	0.48	-	-
<i>Others</i>	0.65	-0.0024	-0.240	0.65	0.0148	1.510	0.67	0.0093	0.890	0.63	-0.0190	-1.450	0.63	0.0294	1.680
<i>In Paid employed</i>	0.54	-	-	0.54	-	-	0.54	-	-	0.49	-	-	0.49	-	-
<i>Self employment</i>	0.08	-0.1140*	-6.880	0.08	-0.0830*	-5.120	0.05	-0.0841*	-4.070	0.05	-0.1215*	-6.130	0.05	-0.0807*	-2.500
<i>Unemployed</i>	0.05	-0.2574*	-9.810	0.05	-0.2529*	-11.000	0.04	-0.2699*	-10.370	0.07	-0.1625*	-4.140	0.07	-0.3249*	-8.760
<i>Retired</i>	0.21	-0.0511*	-2.670	0.21	-0.0434*	-2.070	0.21	-0.0302	-1.470	0.21	-0.0710*	-2.990	0.21	0.0094	0.270
<i>Others</i>	0.13	0.0529*	2.680	0.13	0.2244*	13.430	0.15	0.1992*	12.040	0.19	-0.0033	-0.120	0.19	0.1415*	4.650
<i>No Child</i>	0.74	-	-	0.74	-	-	0.75	-	-	0.88	-	-	0.88	-	-
<i>1 Child</i>	0.11	-0.0472*	-3.190	0.11	-0.0561*	-3.750	0.11	-0.0415*	-2.810	0.07	-0.0499*	-2.710	0.07	-0.0349	-1.130

<i>2 Children</i>	0.11	-0.0286	-1.850	0.11	-0.0535*	-3.370	0.10	-0.0501*	-3.060	0.04	-0.0419*	-2.240	0.04	-0.0250	-0.640
<i>3+ Children</i>	0.04	-0.0209	-0.900	0.04	-0.0309	-1.360	0.04	-0.0526*	-2.080	0.01	-0.0489	-1.880	0.01	0.0840	1.060
<i>Small HH Size</i>	0.17	-0.0165	-1.030	0.17	0.0283	1.750	0.18	0.0399*	2.560	0.36	0.0922	1.060	0.36	-0.0110	-0.590
<i>Medium HH Size</i>	0.53	-	-	0.53	-	-	0.51	-	-	0.30	-	-	0.30	-	-
<i>Big HH Size</i>	0.30	0.0061	0.550	0.30	0.0498*	4.580	0.31	0.0407*	3.630	0.34	-0.0293*	-2.110	0.34	0.0790*	3.520
<i>London</i>	0.08	0.0136	0.770	0.08	-0.0260	-1.340	0.07	-0.0188	-0.960	0.09	0.0136	0.580	0.09	0.0284	1.030
<i>Southeast</i>	0.20	-	-	0.20	-	-	0.21	-	-	0.15	-	-	0.15	-	-
<i>Southwest</i>	0.07	0.0212	1.210	0.07	0.0321	1.690	0.06	-0.0138	-0.700	0.07	-0.0104	-0.470	0.07	0.0859*	2.890
<i>East Anglia</i>	0.03	0.0613*	2.650	0.03	0.0444	1.710	0.03	0.0445	1.640	0.03	0.0622*	2.180	0.03	0.0884*	2.120
<i>Midlands</i>	0.14	0.0174	1.200	0.14	-0.0147	-0.960	0.13	-0.0241	-1.520	0.14	0.0041	0.220	0.14	0.0506*	2.020
<i>Yorkshires</i>	0.08	0.0361*	2.100	0.08	0.0099	0.520	0.07	-0.0107	-0.560	0.07	0.0477*	2.200	0.07	0.0311	1.040
<i>Wales</i>	0.11	0.0288	1.360	0.11	-0.0071	-0.430	0.13	-0.0382*	-2.320	0.11	-0.0213	-0.770	0.11	0.1104*	3.180
<i>Scotland</i>	0.14	0.0179	1.000	0.14	0.0040	0.260	0.17	-0.0396*	-2.630	0.15	-0.0093	-0.400	0.15	0.0704*	2.400
<i>Greater Manchester</i>	0.03	0.0268	1.110	0.03	-0.0339	-1.270	0.03	-0.0231	-0.880	0.04	0.0075	0.240	0.04	0.0967*	2.500
<i>North</i>	0.11	0.0195	1.250	0.11	-0.0050	-0.300	0.09	-0.0010	-0.060	0.10	-0.0074	-0.370	0.10	0.0750*	2.800
<i>LR chi2(41)=</i>	3196.46	<i>LR chi2(40)=</i>		3154.17			2989.96			1739.64			1415.57		
<i>Pseudo R2</i>	0.0209			0.0205			0.0201			0.0188			0.0256		
<i>Number of Obs.</i>	60626			60062			58736			37130			21790		

Dependent Variable = *Fisite* (BHPS: 1991~2002)

<i>Probit Model</i>	<i>Secondary Edu.</i>			<i>High Education</i>			<i>Others</i>			<i>Consistency</i>		
	<i>Mean</i>	<i>Coef</i>	<i>T-Stat.</i>	<i>Mean</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Mean.</i>	<i>Coef.</i>	<i>T-Stat.</i>	<i>Coef.</i>	<i>T-Stat.</i>	
<i>Deteriorated</i>	0.08	-0.2779*	-7.82	0.10	-0.1741*	-7.91	0.09	-0.2086*	-11.32	<i>Fisite_1</i>	-0.06	-10.3500
<i>Same</i>	0.22			0.30	-	-	0.27	-	-			
<i>Improved</i>	0.71	0.3687*	18.14	0.60	0.2844*	22.64	0.64	0.3106*	29.55	--		
<i>Age</i>	38.04	-0.0036	-1.010	48.17	0.0002	0.090	44.88	-0.0032	-1.850	--	--	--
<i>Age.Age/100</i>	16.75	0.0056	1.440	26.99	0.0056*	2.710	23.63	0.0075*	4.300	--	--	--
<i>Log of Income</i>	4.12	0.1432*	13.160	3.67	0.0784*	9.410	3.84	0.1073*	17.040	--	--	--
<i>Income Variance</i>	-	0.0000*	-3.870	-	0.0000*	-3.470	-	0.0000*	-3.420	--	--	--
<i>No married</i>	0.49	-	-	0.45	-	-	0.46	-	-	--	--	--
<i>Married</i>	0.51	0.0733*	3.200	0.55	0.0233	1.380	0.54	0.0464*	3.500	--	--	--
<i>Male</i>	0.57	-	-	0.48	-	-	0.50	-	-	--	--	--
<i>Female</i>	0.43	0.1163*	7.080	0.52	0.0771*	6.370	0.50	0.0944*	9.950	--	--	--
<i>No Smoker</i>	0.76	-	-	0.68	-	-	0.71	-	-	--	--	--
<i>Smokers</i>	0.24	-0.0658*	-3.340	0.32	-0.0536*	-4.290	0.29	-0.0570*	-5.500	--	--	--
<i>Housing Owned</i>	0.19	-	-	0.27			0.24	-	-	--	--	--
<i>Housing Mortgage</i>	0.60	-0.0557*	-2.350	0.42	0.0048	0.310	0.48	-0.0076	-0.600	--	--	--
<i>Housing Rented</i>	0.21	-0.0172	-0.570	0.32	0.0573*	3.680	0.28	0.0485*	3.600	--	--	--
<i>Secondary Education</i>	--	--	--	--	--	--	--	--	--	--	--	--
<i>Higher Education</i>	--	--	--	--	--	--	--	--	--	--	--	--
<i>Others</i>	--	--	--	--	--	--	--	--	--	--	--	--
<i>In Paid employed</i>	0.66	-	-	0.48	-	-	0.54	-	-	--	--	--
<i>Self employment</i>	0.09	-0.0833*	-3.110	0.07	-0.1071*	-4.920	0.08	-0.1141*	-6.890	--	--	--
<i>Unemployed</i>	0.03	-0.3289*	-6.520	0.05	-0.2445*	-7.750	0.05	-0.2576*	-9.830	--	--	--
<i>Retired</i>	0.09	-0.1016*	-2.480	0.27	-0.0685*	-3.090	0.21	-0.0518*	-2.710	--	--	--
<i>Others</i>	0.13	0.1338*	3.630	0.13	-0.0059	-0.240	0.13	0.0515*	2.620	--	--	--
<i>No Child</i>	0.71	-	-	0.76	-	-	0.74	-	-	--	--	--
<i>1 Child</i>	0.13	-0.0307	-1.270	0.10	-0.0446*	-2.290	0.11	-0.0475*	-3.220	--	--	--
<i>2 Children</i>	0.12	-0.0587*	-2.360	0.10	0.0034	0.160	0.11	-0.0288	-1.870	--	--	--
<i>3+ Children</i>	0.04	-0.0306	-0.750	0.04	0.0114	0.390	0.04	-0.0190	-0.820	--	--	--
<i>Small HH Size</i>	0.14	-0.0089	-0.320	0.18	-0.0261	-1.300	0.17	-0.0166	-1.050	--	--	--

Medium HH Size	0.56	-	-	0.51	-	-	0.53	-	-	--	--	--
Big HH Size	0.30	0.0236	1.200	0.30	-0.0009	-0.060	0.30	0.0067	0.610	--	--	--
London	0.09	0.0431	1.470	0.07	0.0028	0.120	0.08	0.0143	0.820	--	--	--
Southeast	0.21	-	-	0.20	-	-	0.20	-	-	--	--	--
Southwest	0.06	0.0435	1.340	0.08	0.0191	0.900	0.07	0.0231	1.330	--	--	--
East Anglia	0.03	0.0848*	2.040	0.03	0.0555*	1.960	0.03	0.0612*	2.640	--	--	--
Midlands	0.13	0.0199	0.770	0.15	0.0114	0.630	0.14	0.0180	1.240	--	--	--
Yorkshires	0.07	0.0889*	2.840	0.08	0.0178	0.840	0.08	0.0367*	2.130	--	--	--
Wales	0.10	0.0486	1.350	0.11	0.0266	1.000	0.11	0.0291	1.370	--	--	--
Scotland	0.18	0.0092	0.320	0.12	0.0139	0.590	0.14	0.0185	1.040	--	--	--
Greater Manchester	0.03	0.0186	0.460	0.03	0.0265	0.880	0.03	0.0253	1.050	--	--	--
North	0.09	-0.0002	-0.010	0.11	0.0319	1.650	0.11	0.0210	1.350	--	--	--
LR chi2(39)=	1391.93			1785.25			3211.8					
Pseudo R2	0.0271			0.0185			0.021			LR chi2(1)=	107.06	
Number of Obs.	19223			39888			60818			70418		

Sources: 1991 to 2002 yearly BHPS samples.

- 1) UK CPI for obtaining real income figures in 1991.
- 2) \* = significant at 5%.
- 3) Year dummies are jointly estimated.
- 4) Null hypothesis: coefficient corresponding to explanatory variable is equal to zero.

## Appendix C

### Random Effect Ordered Probit Model

Consider a random effect model:

$$y_{it}^* = x_{it}'\beta + u_{it} \quad i=1, 2, \dots, n \text{ and } t=1, \dots, T$$

where

$$u_{it} = \mu_i + v_{it}$$

$$Var(u_{it}) = \sigma_\mu^2 + \sigma_v^2 = 1 + \sigma_u^2$$

$$Corr(u_{it}, u_{is}) = \rho = \frac{\sigma_\mu^2}{1 + \sigma_\mu^2}$$

and

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^* \leq \delta_0, \\ 1 & \text{if } \delta_0 < y_{it}^* \leq \delta_1 \\ 2 & \text{if } \delta_1 < y_{it}^* \leq \delta_2 \\ \vdots & \\ M & \\ J & \text{if } \delta_{J-1} < y_{it}^* \end{cases}$$

where  $y^*$  denotes the unobservable variable, what we observe in our analysis is  $y_{it} = \{1, 2, 3\}$  if  $\{y_{it}^* \leq \delta_0, \delta_0 < y_{it}^* \leq \delta_1, \delta_1 < y_{it}^* \leq \delta_2\}$ ;  $y$  is the observed outcome;  $x$  is observable time varying and time invariant vector of strictly exogenous characteristics which influence  $y^*$ ;  $\beta$  is the vector of coefficients associated with the  $x$ ;  $\mu_i$  denotes the individual specific unobservable effect, which is treated as a random effect and assumed to be normally distributed; while the  $v_{it}$  is a random error. In the case of probit random effect models it is also assumed that  $v_{it} \sim IN(0, \sigma_v^2)$  and  $\sigma_v = 1$ <sup>81</sup>. The random effect ordered

<sup>81</sup>  $Var(u_{it}) = \sigma_\mu^2 + \sigma_v^2 = 1 + \sigma_\mu^2$ , and the cross-period correlation of  $u_{it}$  is:  $Corr(u_{it}, u_{is}) = \rho = \sigma_\mu^2 / (1 + \sigma_\mu^2)$  if  $t \neq s$ . If the random effects exists,  $u_{it}$  and  $u_{is}$  are correlated within a group, but not correlated across groups. If the effects are not significant,  $\sigma_\mu^2 = 0$  and  $\rho = \sigma_\mu^2 / (1 + \sigma_\mu^2) = 0$ , which indicates there is no cross-period correlation with respect to  $u_{it}$ . To test for random effects, we examine the

probit model is estimated by the log-likelihood function introduced by Butler and Moffitt (1982) and the Gauss-Hermite quadrature method deals with the random effects structure in the model. In order to marginalize the likelihood we assume that  $\mu_i \sim IN(0, \sigma_\mu^2)$  are independent of the  $x_{it}$ s and the  $v_{it}$  conditional on the  $x_{it}$ s.

If we define  $a_{it} = \delta_{j-1} - x'_{it}\beta$  and  $b_{it} = \delta_j - x'_{it}\beta$  if  $y_{it} = j$ , where  $\delta_{-1} = -\infty$  and  $\delta_j = \infty$  the log-likelihood function is  $L = \sum_{i=1}^N \ln(P(y_{i1}, y_{i2}, \dots, y_{iT}))$  where, by simply generalizing the argument made in Butler and Moffitt (1982), one can show that

$$\begin{aligned} P(y_{i1}, y_{i2}, \dots, y_{iT}) &= \int_{a_{i1}}^{b_{i1}} \dots \int_{a_{iT}}^{b_{iT}} f(u_{i1}, \dots, u_{iT}) du_{iT} \dots du_{i1} \\ &= \int_{a_{i1}}^{b_{i1}} \dots \int_{a_{iT}=-\infty}^{b_{iT}=\infty} \prod_{t=1}^T f(v_{it} | \mu_i) f(\mu_i) d\mu_i dv_{iT} \dots dv_{i1} \\ &= \int_{-\infty}^{\infty} \prod_{t=1}^T [F(b_{it} | \mu_i) - F(a_{it} | \mu_i)] d\mu_i \end{aligned}$$

in which  $f(\bullet)$  and  $F(\bullet)$  represent the *pdf* and *cdf* of the normal distribution function respectively. Butler and Moffitt demonstrate that this is amenable to Gaussian quadrature. It is sufficient to estimate such a model as one can use numerical approximation of the first and second derivatives to compute quasi-Newton steps. However, while this makes each step time consuming to compute, even for a relatively small sample. The first derivatives can be approximated by Gauss-Hermite quadrature. Using the convention that  $f_{it}^j = f(u_j - x'_{it}\beta)$ ,  $F_{it}^j = F(u_j - x'_{it}\beta)$ ,  $L_i = P(y_{i1}, y_{i2}, \dots, y_{iT})$ , and an indicator function  $1\{Statement\}$  which takes the value 1 if the statement is true and 0 otherwise, the first derivative with respect to a parameter  $k$  is given by

$$\frac{\partial L}{\partial k} = \frac{\partial \sum_i \ln L_i}{\partial k} = \sum_i \frac{1}{L_i} \frac{\partial L_i}{\partial k}$$

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statistical significance of  $\rho$ , using the *Wald* test statistics ( $w = \rho^2 / s_\rho^2$ ). If  $w > \chi^2$  critical value (3.84 for a 95% critical level), we can reject the null of  $\rho = 0$  (Greene, 2000).

and thus for our parameters of interest

$$\frac{\partial L_i}{\partial \beta} = \int_{-\infty}^{\infty} f(\mu_i) \sum_{t=1}^T \frac{f_{it}^{j-1} - f_{it}^j}{F_{it}^j - F_{it}^{j-1}} x_{it} \prod_{t=1}^T [F(b_{it} | \mu_i) - F(a_{it} | \mu_i)] d\mu_i$$

$$\frac{\partial L_i}{\partial u_i} = \int_{-\infty}^{\infty} f(u_i) \sum_{t=1}^T \frac{f_{it}^{j-1} 1\{y_{it} = j\} - f_{it}^j 1\{y_{it} = j-1\}}{F_{it}^j - F_{it}^{j-1}} \prod_{t=1}^T [F(b_{it} | \mu_i) - F(a_{it} | \mu_i)] d\mu_i$$

$$\frac{\partial L_i}{\partial \rho} = \int_{-\infty}^{\infty} f(\mu_i) \sum_{t=1}^T \frac{f_{it}^{j-1} - f_{it}^j}{F_{it}^j - F_{it}^{j-1}} \frac{\sqrt{1-\rho}}{\sqrt{2\rho(1-\rho)}} \prod_{t=1}^T [F(b_{it} | \mu_i) - F(a_{it} | \mu_i)] d\mu_i$$



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